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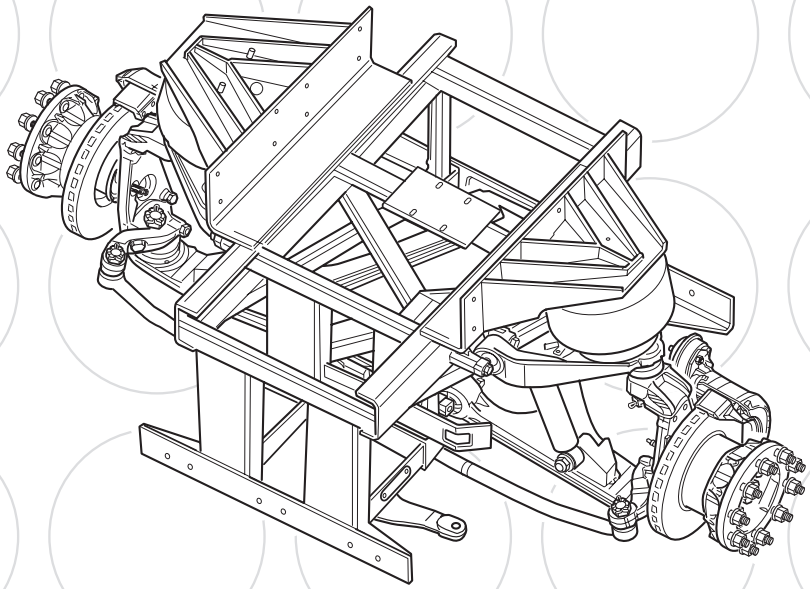
MERITOR®

an *ArvinMeritor* brand

Maintenance Manual MM-0368

RideStar™ RIS13EF and RIS16EF Series Independent Front Suspension (IFS) Systems

Issued 06-05



Service Notes

About This Manual

This manual provides maintenance and service information for the Meritor RideStar™ RIS13EF and RIS16EF Series Independent Front Suspension (IFS) systems.

Before You Begin

1. Read and understand all instructions and procedures before you begin to service components.
2. Read and observe all Warning and Caution hazard alert messages in this publication. They provide information that can help prevent serious personal injury, damage to components, or both.
3. Follow your company's maintenance and service, installation, and diagnostics guidelines.
4. Use special tools when required to help avoid serious personal injury and damage to components.

Hazard Alert Messages and Torque Symbols

⚠ WARNING

A Warning alerts you to an instruction or procedure that you must follow exactly to avoid serious personal injury and damage to components.

⚠ CAUTION

A Caution alerts you to an instruction or procedure that you must follow exactly to avoid damage to components.

This symbol alerts you to tighten fasteners to a specified torque value.

How to Obtain Additional Maintenance and Service Information

On the Web

Visit the DriveTrain Plus™ by ArvinMeritor Tech Library at arvinmeritor.com to easily access product and service information. The Library also offers an interactive and printable Literature Order Form.

ArvinMeritor's Customer Service Center

Call ArvinMeritor's Customer Service Center at 800-535-5560.

Technical Electronic Library on CD

The DriveTrain Plus™ by ArvinMeritor Technical Electronic Library on CD contains product and service information for most Meritor and Meritor WABCO products. $20. Specify TP-9853.

How to Obtain Tools and Supplies Specified in This Manual

Call ArvinMeritor's Commercial Vehicle Aftermarket at 888-725-9355 to obtain Meritor tools and supplies.

Contents

Asbestos and Non-Asbestos Fibers

⚠ ASBESTOS FIBERS WARNING

The following procedures for servicing brakes are recommended to reduce exposure to asbestos fiber dust, a cancer and lung disease hazard. Material Safety Data Sheets are available from ArvinMeritor.

Hazard Summary

Because some brake linings contain asbestos, workers who service brakes must understand the potential hazards of asbestos and precautions for reducing risks. Exposure to airborne asbestos dust can cause serious and possibly fatal diseases, including asbestosis (a chronic lung disease) and cancer, principally lung cancer and mesothelioma (a cancer of the lining of the chest or abdominal cavities). Some studies show that the risk of lung cancer among persons who smoke and who are exposed to asbestos is much greater than the risk for non-smokers. Symptoms of these diseases may not become apparent for 15, 20 or more years after the first exposure to asbestos.

Accordingly, workers must use caution to avoid creating and breathing dust when servicing brakes. Specific recommended work practices for reducing exposure to asbestos dust follow. Consult your employer for more details.

Recommended Work Practices

1. Separate Work Areas. Whenever feasible, service brakes in a separate area away from other operations to reduce risks to unprotected persons. OSHA has set a maximum allowable level of exposure for asbestos of 0.1 f/cc as an 8-hour time-weighted average and 1.0 f/cc averaged over a 30-minute period. Scientists disagree, however, to what extent adherence to the maximum allowable exposure levels will eliminate the risk of disease that can result from inhaling asbestos dust. OSHA requires that the following sign be posted at the entrance to areas where exposures exceed either of the maximum allowable levels:

DANGER: ASBESTOS
CANCER AND LUNG DISEASE HAZARD
AUTHORIZED PERSONNEL ONLY
RESPIRATORS AND PROTECTIVE CLOTHING
ARE REQUIRED IN THIS AREA.

2. Respiratory Protection. Wear a respirator equipped with a high-efficiency (HEPA) filter approved by NIOSH or MSHA for use with asbestos at all times when servicing brakes, beginning with the removal of the wheels.

3. Procedures for Servicing Brakes.

a. Enclose the brake assembly within a negative pressure enclosure. The enclosure should be equipped with a HEPA vacuum and worker arm sleeves. With the enclosure in place, use the HEPA vacuum to loosen and vacuum residue from the brake parts.

b. As an alternative procedure, use a catch basin with water and a biodegradable, non-phosphate, water-based detergent to wash the brake drum or rotor and other brake parts. The solution should be applied with low pressure to prevent dust from becoming airborne. Allow the solution to flow between the brake drum and the brake support or the brake rotor and caliper. The wheel hub and brake assembly components should be thoroughly wetted to suppress dust before the brake shoes or brake pads are removed. Wipe the brake parts clean with a cloth.

c. If an enclosed vacuum system or brake washing equipment is not available, employers may adopt their own written procedures for servicing brakes, provided that the exposure levels associated with the employer's procedures do not exceed the levels associated with the enclosed vacuum system or brake washing equipment. Consult OSHA regulations for more details.

d. Wear a respirator equipped with a HEPA filter approved by NIOSH or MSHA for use with asbestos when grinding or machining brake linings. In addition, do such work in an area with a local exhaust ventilation system equipped with a HEPA filter.

e. **NEVER** use compressed air by itself, dry brushing, or a vacuum not equipped with a HEPA filter when cleaning brake parts or assemblies. **NEVER** use carcinogenic solvents, flammable solvents, or solvents that can damage brake components as wetting agents.

4. Cleaning Work Areas. Clean work areas with a vacuum equipped with a HEPA filter or by wet wiping. **NEVER** use compressed air or dry sweeping to clean work areas. When you empty vacuum cleaners and handle used rags, wear a respirator equipped with a HEPA filter approved by NIOSH or MSHA for use with asbestos. When you replace a HEPA filter, wet the filter with a fine mist of water and dispose of the used filter with care.

5. Worker Clean-Up**.** After servicing brakes, wash your hands before you eat, drink or smoke. Shower after work. Do not wear work clothes home. Use a vacuum equipped with a HEPA filter to vacuum work clothes after they are worn. Launder them separately. Do not shake or use compressed air to remove dust from work clothes.

6. Waste Disposal. Dispose of discarded linings, used rags, cloths and HEPA filters with care, such as in sealed plastic bags. Consult applicable EPA, state and local regulations on waste disposal.

Regulatory Guidance

References to OSHA, NIOSH, MSHA, and EPA, which are regulatory agencies in the United States, are made to provide further guidance to employers and workers employed within the United States. Employers and workers employed outside of the United States should consult the regulations that apply to them for further guidance.

⚠ NON-ASBESTOS FIBERS WARNING

The following procedures for servicing brakes are recommended to reduce exposure to non-asbestos fiber dust, a cancer and lung disease hazard. Material Safety Data Sheets are available from ArvinMeritor.

Hazard Summary

Most recently manufactured brake linings do not contain asbestos fibers. These brake linings may contain one or more of a variety of ingredients, including glass fibers, mineral wool, aramid fibers, ceramic fibers and silica that can present health risks if inhaled. Scientists disagree on the extent of the risks from exposure to these substances. Nonetheless, exposure to silica dust can cause silicosis, a non-cancerous lung disease. Silicosis gradually reduces lung capacity and efficiency and can result in serious breathing difficulty. Some scientists believe other types of non-asbestos fibers, when inhaled, can cause similar diseases of the lung. In addition, silica dust and ceramic fiber dust are known to the State of California to cause lung cancer. U.S. and international agencies have also determined that dust from mineral wool, ceramic fibers and silica are potential causes of cancer.

Accordingly, workers must use caution to avoid creating and breathing dust when servicing brakes. Specific recommended work practices for reducing exposure to non-asbestos dust follow. Consult your employer for more details.

Recommended Work Practices

1. Separate Work Areas. Whenever feasible, service brakes in a separate area away from other operations to reduce risks to unprotected persons.

2. Respiratory Protection. OSHA has set a maximum allowable level of exposure for silica of 0.1 mg/m^3 as an 8-hour time-weighted average. Some manufacturers of non-asbestos brake linings recommend that exposures to other ingredients found in non-asbestos brake linings be kept below 1.0 f/cc as an 8-hour time-weighted average. Scientists disagree, however, to what extent adherence to these maximum allowable exposure levels will eliminate the risk of disease that can result from inhaling non-asbestos dust.

Therefore, wear respiratory protection at all times during brake servicing, beginning with the removal of the wheels. Wear a respirator equipped with a high-efficiency (HEPA) filter approved by NIOSH or MSHA, if the exposure levels may exceed OSHA or manufacturers' recommended maximum levels. Even when exposures are expected to be within the maximum allowable levels, wearing such a respirator at all times during brake servicing will help minimize exposure.

3. Procedures for Servicing Brakes.

a. Enclose the brake assembly within a negative pressure enclosure. The enclosure should be equipped with a HEPA vacuum and worker arm sleeves. With the enclosure in place, use the HEPA vacuum to loosen and vacuum residue from the brake parts.

b. As an alternative procedure, use a catch basin with water and a biodegradable, non-phosphate, water-based detergent to wash the brake drum or rotor and other brake parts. The solution should be applied with low pressure to prevent dust from becoming airborne. Allow the solution to flow between the brake drum and the brake support or the brake rotor and caliper. The wheel hub and brake assembly components should be thoroughly wetted to suppress dust before the brake shoes or brake pads are removed. Wipe the brake parts clean with a cloth.

c. If an enclosed vacuum system or brake washing equipment is not available, carefully clean the brake parts in the open air. Wet the parts with a solution applied with a pump-spray bottle that creates a fine mist. Use a solution containing water, and, if available, a biodegradable, non-phosphate, water-based detergent. The wheel hub and brake assembly components should be thoroughly wetted to suppress dust before the brake shoes or brake pads are removed. Wipe the brake parts clean with a cloth.

d. Wear a respirator equipped with a HEPA filter approved by NIOSH or MSHA when grinding or machining brake linings. In addition, do such work in an area with a local exhaust ventilation system equipped with a HEPA filter.

e. **NEVER** use compressed air by itself, dry brushing, or a vacuum not equipped with a HEPA filter when cleaning brake parts or assemblies. **NEVER** use carcinogenic solvents, flammable solvents, or solvents that can damage brake components as wetting agents.

4. Cleaning Work Areas. Clean work areas with a vacuum equipped with a HEPA filter or by wet wiping. **NEVER** use compressed air or dry sweeping to clean work areas. When you empty vacuum cleaners and handle used rags, wear a respirator equipped with a HEPA filter approved by NIOSH or MSHA, to minimize exposure. When you replace a HEPA filter, wet the filter with a fine mist of water and dispose of the used filter with care.

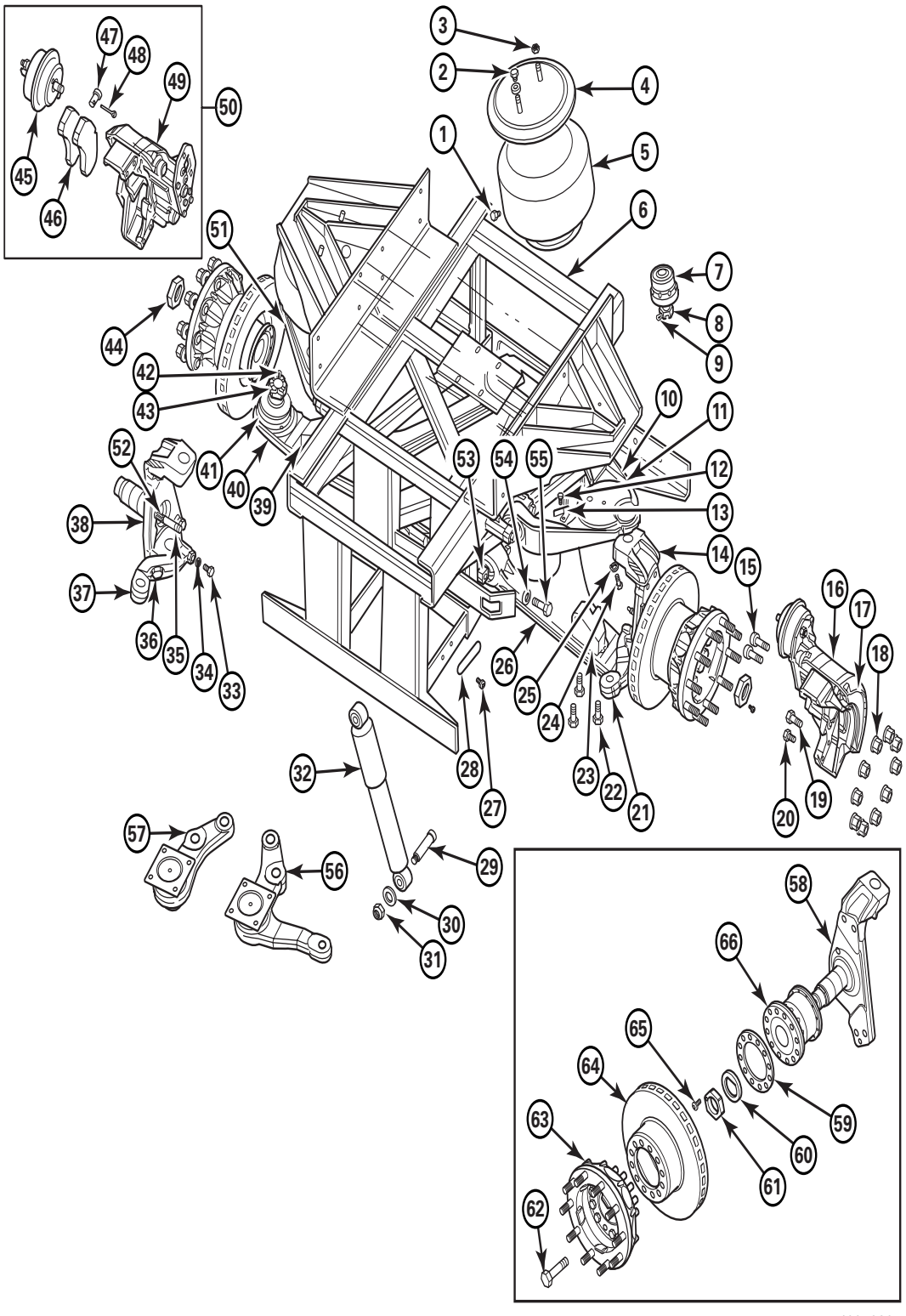
5. Worker Clean-Up. After servicing brakes, wash your hands before you eat, drink or smoke. Shower after work. Do not wear work clothes home. Use a vacuum equipped with a HEPA filter to vacuum work clothes after they are worn. Launder them separately. Do not shake or use compressed air to remove dust from work clothes.

6. Waste Disposal**.** Dispose of discarded linings, used rags, cloths and HEPA filters with care, such as in sealed plastic bags. Consult applicable EPA, state and local regulations on waste disposal.

Regulatory Guidance

References to OSHA, NIOSH, MSHA, and EPA, which are regulatory agencies in the United States, are made to provide further guidance to employers and workers employed within the United States. Employers and workers employed outside of the United States should consult the regulations that apply to them for further guidance.

1 Exploded Views

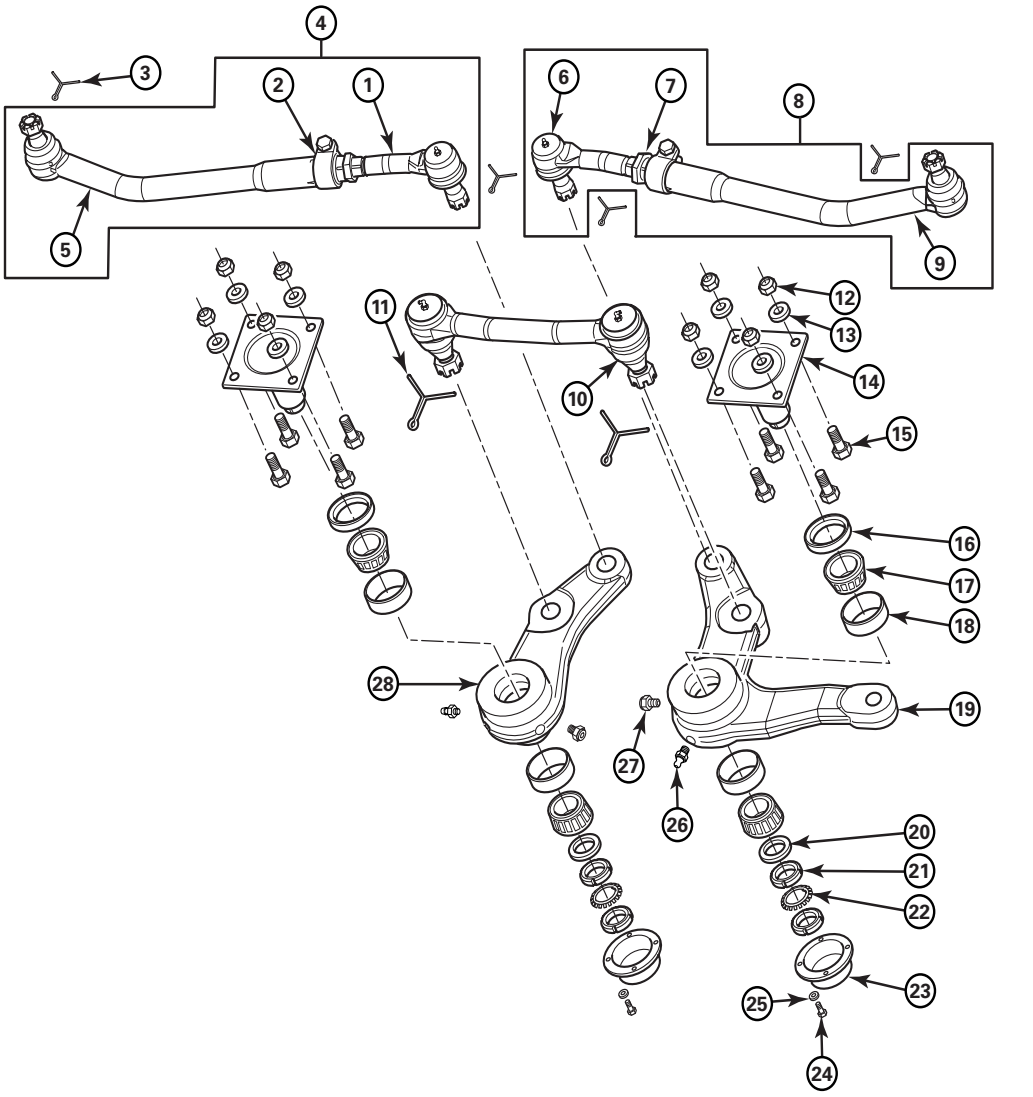


1 Exploded Views

Item	Description
1	M16 x 1.5 to 3/8-18 NPTF Adapter
2	M16 x 1.5 Plug
3	M12 x 1.75 Locknut
4	Air Spring Support Plate
5	Air Spring
6	Subframe Assembly
7	65 mm Ball Stud Assembly
8	M36 x 1.5 Castle Nut
9	Cotter Pin
10	Suspension Assembly
11	Left-Hand Upper Control Arm
12	M8 x 1.25 x 16 Capscrew
13	Level Sensor Bracket
14	Left-Hand Steering Knuckle Assembly
15	M20 x 1.5 x 60 Socket Head Capscrew
16	Left-Hand Disc Brake Assembly
17	Left-Hand Disc Brake
18	M22 x 1.5 Nut Assembly
19	M20 x 1.5 x 60 Capscrew
20	M20 x 1.5 x 45 Capscrew
21	Left-Hand Steering Arm
22	M16 x 2 x 60 Socket Head Capscrew
23	Left-Hand Shock Absorber Bracket
24	M14 x 2 x 40 Capscrew
25	M14 Lock Washer
26	Left-Hand Lower Control Arm
27	Pop Rivet
28	Name Plate
29	0.75-10 Shoulder Bolt
30	Flat Washer
31	3/4-10 Locknut
32	Shock Absorber
33	M14 x 1.5 Steering Stop Screw
34	M14 Jam Nut
35	ABS Sensor

Item	Description
36	M20 x 1.5 x 70 Capscrew
37	Right-Hand Steering Arm
38	Right-Hand Steering Knuckle
39	Right Hand Shock Absorber Bracket
40	Right-Hand Lower Control Arm
41	80 mm Ball Stud Assembly
42	Cotter Pin
43	M42 x 1.5 Castle Nut
44	Right-Hand M55 x 2 Spindle Nut, Left-Hand Thread
45	Brake Chamber Assembly
46	Brake Shoe and Lining Assembly
47	Clevis Pin
48	Cotter Pin
49	Right-Hand Disc Brake
50	Right-Hand Disc Brake Assembly
51	Right-Hand Upper Control Arm
52	Sensor Bushing
53	Bushing Assembly
54	Washer
55	Capscrew
56	Steering Relay Arm
57	Steering Idler Arm
58	Knuckle
59	Spacer
60	Washer
61	Left-Hand M55 x 2 Spindle Nut, Right-Hand Thread
62	M18 x 1.5 x 80 Capscrew
63	Wheel Adapter Assembly
64	Rotor
65	M8 x 1.25 x 20 Socket Head Capscrew
66	Unitized Wheel-End Assembly

1 Exploded Views



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Item	Description
1	Right-Hand Tie Rod End
2	Clamp Nut
3	1/8 x 2.0 Cotter Pin
4	Right-Hand Tie Rod Assembly
5	Right-Hand Tie Rod
6	Left-Hand Tie Rod End
7	Slotted Sleeve
8	Left-Hand Tie Rod Assembly
9	Left-Hand Tie Rod
10	Relay Rod Assembly
11	3/16 x 2.5 Cotter Pin
12	Locknut
13	Washer
14	Pivot Shaft
15	5/8″-11 Capscrew
16	Grease Seal
17	Bearing Cone
18	Bearing Cup
19	Steering Relay Arm
20	Washer
21	Locknut
22	Washer
23	Cover
24	Capscrew
25	Washer
26	Grease Fitting
27	Relief Fitting
28	Steering Idler Arm

2 Introduction

Description

The RideStar™ RIS13EF and RIS16EF Series Independent Front Suspension (IFS) systems are up to 16,000-lb capacity independent front suspension systems which include a short arm/long arm independent suspension, air springs, Gabriel shock absorbers, steering linkage and a subframe. Suspension travel is 3.5-inches (90 mm) of jounce travel and 3.5-inches (90 mm) of rebound travel.

For maintenance and service information about the other Meritor components, such as brakes, refer to the appropriate maintenance manual. To obtain these publications, refer to the Service Notes page on the front inside cover of this manual.

Model Nomenclature

Model Numbers and Designations

An identification tag is located on the lower left-hand side of the subframe. Figure 2.1. To obtain replacement parts, refer to the Service Notes page on the front inside cover of this manual and specify the complete model number on the tag. The model number on the identification tag provides the suspension designation. Figure 2.2.

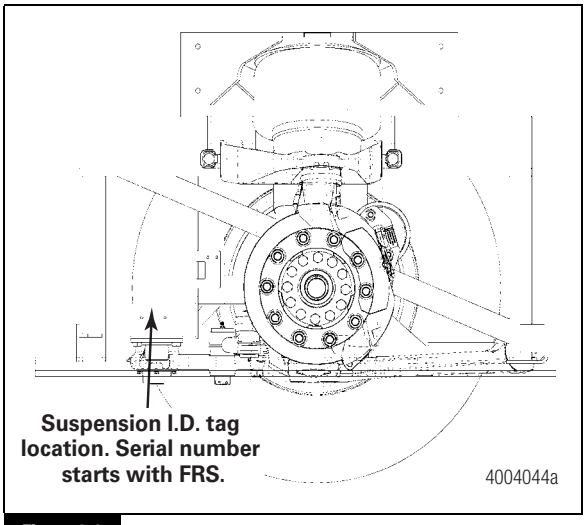

Figure 2.1

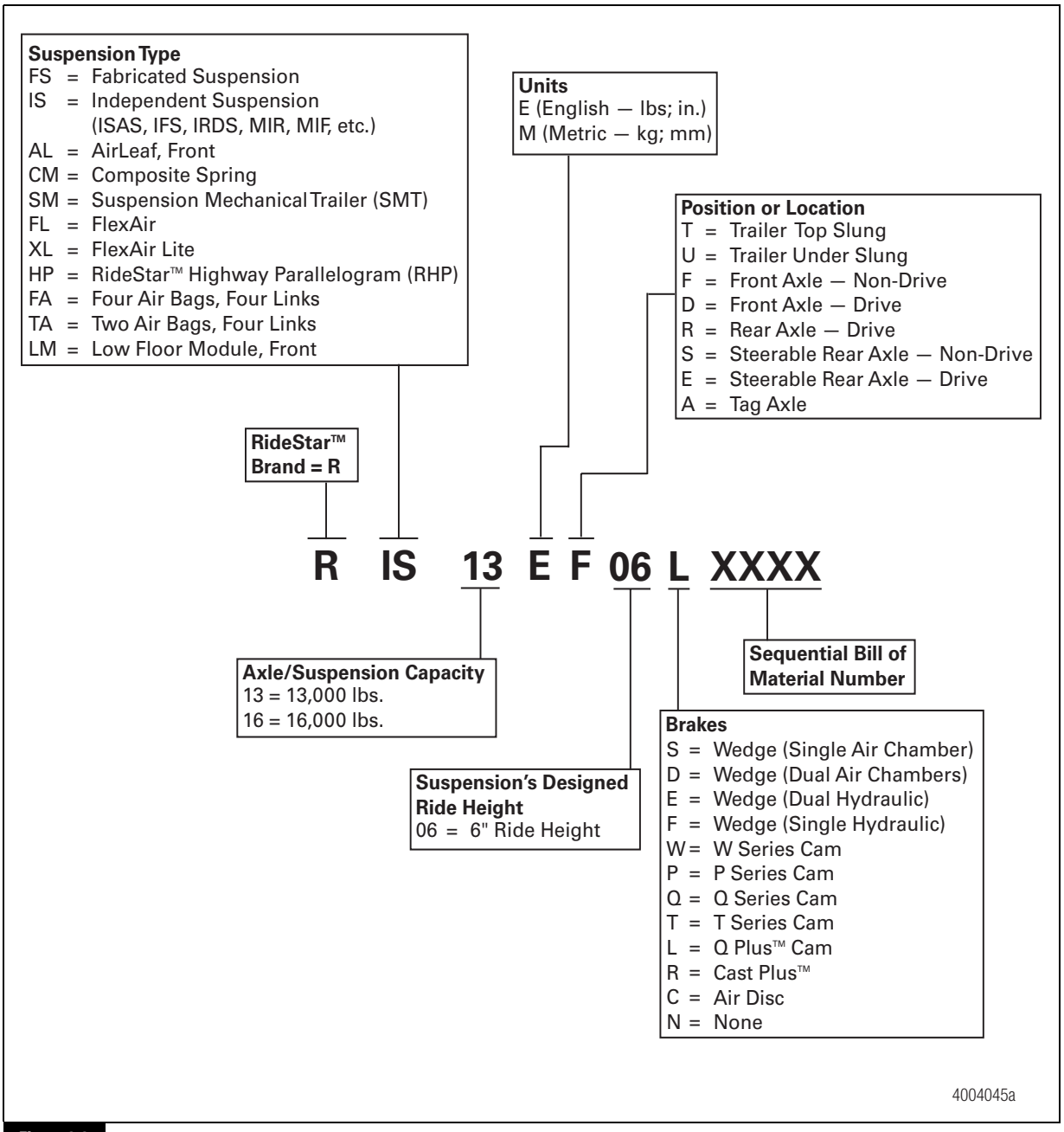
Suspension Type
FS = Fabricated Suspension
IS = Independent Suspension
(ISAS, IFS, IRDS, MIR, MIF, etc.)
AL = AirLeaf, Front
CM = Composite Spring
SM = Suspension Mechanical Trailer (SMT)
FL = FlexAir
XL = FlexAir Lite
HP = RideStar™ Highway Parallelogram (RHP)
FA = Four Air Bags, Four Links
TA = Two Air Bags, Four Links
LM = Low Floor Module, Front
Units
E (English — lbs; in.)
M (Metric — kg; mm)
Position or Location
T = Trailer Top Slung
U = Trailer Under Slung
F = Front Axle — Non-Drive
D = Front Axle — Drive
R = Rear Axle — Drive
S = Steerable Rear Axle — Non-Drive
E = Steerable Rear Axle — Drive
A = Tag Axle
RideStar™ Brand = R
R IS 13 E F 06 L XXXX
Axle/Suspension Capacity
13 = 13,000 lbs.
16 = 16,000 lbs.
Suspension's Designed Ride Height
06 = 6" Ride Height
Sequential Bill of Material Number
Brakes
S = Wedge (Single Air Chamber)
D = Wedge (Dual Air Chambers)
E = Wedge (Dual Hydraulic)
F = Wedge (Single Hydraulic)
W = W Series Cam
P = P Series Cam
Q = Q Series Cam
T = T Series Cam
L = Q Plus™ Cam
R = Cast Plus™
C = Air Disc
N = None
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Figure 2.2

3 Suspension Ride Height, Travel and Tire Clearance

Suspension Ride Height

Suspension ride height is the distance from the centerline of the suspension to the underside of the vehicle frame. Figure 3.1.

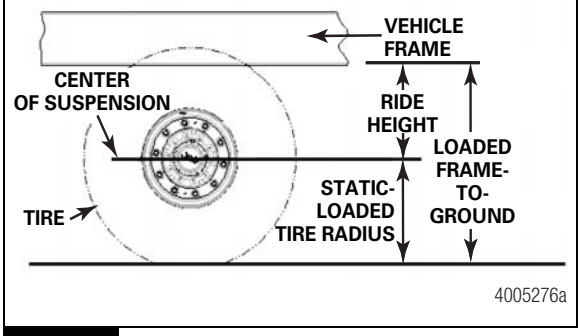


Figure 3.1

All Meritor air suspensions are designed to operate at a specific ride height, which must be maintained during the life of the suspension. Otherwise incorrect loading can occur, which can affect suspension performance, shorten component life and void the Meritor warranty.

Operating a vehicle with ride height higher than specified by the application can cause the vehicle to be over the legal height limit, depending on the type of vehicle and payload.

To obtain the correct ride-height specification, check the suspension's identification tag located on the lower left-hand side of the subframe.

How to Determine the Correct Ride Height

Consider the following factors when you determine the correct suspension ride height.

Vehicle Frame-to-Ground Distance

You must measure the distance from the bottom of the vehicle frame to the ground at each suspension location. Figure 3.2. This measurement determines the required vehicle height. Refer to the vehicle manufacturer's information for ride height specifications and adjustment procedures.

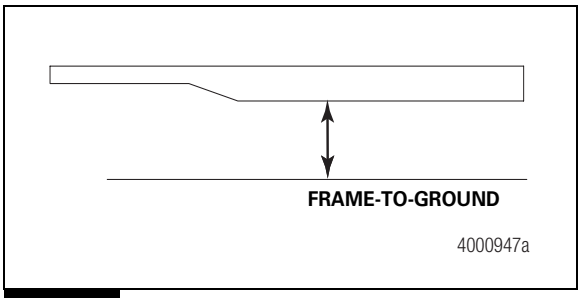


Figure 3.2

Suspension Ride Height Calculation

To calculate the required suspension ride height, subtract the tire's static-loaded radius from the loaded frame-to-ground dimension. Figure 3.1.

Suspension Travel

Jounce and Rebound

Jounce is the amount of upward suspension travel from the suspension's designed ride-height position. Figure 3.3. The suspension has 3.5-inches (90 mm) of jounce.

Rebound is the amount of downward suspension travel from the suspension's designed ride-height position. Figure 3.3. The suspension has 3.5-inches (90 mm) of rebound.

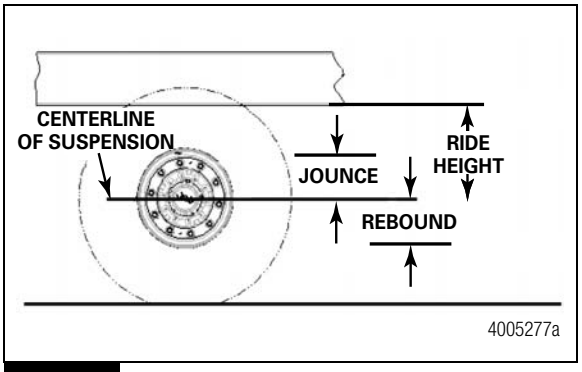


Figure 3.3

Hazard Alert Messages

Read and observe all Warning and Caution hazard alert messages in this publication. They provide information that can help prevent serious personal injury, damage to components, or both.

⚠ WARNING

To prevent serious eye injury, always wear safe eye protection when you perform vehicle maintenance or service.

Take care when you use Loctite® adhesive to avoid serious personal injury. Read the manufacturer's instructions before using this product. Follow the instructions carefully to prevent irritation to the eyes and skin.

Always deflate the air springs before you begin service procedures. Do not service the air suspension on a vehicle with the air springs inflated. Serious personal injury and damage to components can result.

Check fastener torque values, tighten loose fasteners and replace damaged fasteners. Loose, damaged or missing fasteners can cause loss of vehicle control, serious personal injury and damage to components.

Intervals

Inspect the suspension components annually or at regular intervals during normal operation.

Before each trip, visually inspect the suspension system and listen for air leaks.

Inspect the shock absorbers, air springs and bushings when the axle or brakes are inspected. Replace the components as necessary.

After 1,000 miles (1609 km) of service on a new vehicle and after component replacement, tighten all fasteners to the specified torque. Refer to Section 9 for torque specifications.

At each preventive maintenance inspection, or annually, visually inspect all fasteners for looseness or movement. Tighten loose fasteners to the specified torque. Refer to Section 9 for torque specifications.

If the fastener has Loctite® threadlocker and turns, remove the fastener and clean off the threads. Apply new Loctite® threadlocker and install the fastener according to the instructions in Section 7.

Replace damaged fasteners to maintain the specified torque and to comply with warranty requirements.

When replacing any suspension component, never reuse capscrews, washers or locknuts.

Table A

	Service Intervals			
Component	**20,000 Miles (32 200 km)**	**40,000 Miles (64 000 km)**	**80,000 Miles (128 747 km)**	**200,000 Miles (320 000 km)**
Control Arm Bar Pin-to-Subframe Mounting Capscrews				I
Steering Assembly-to-Frame Locknuts				I
Tie Rod Ends[1]	I	L[2]		
Tie Rod Assembly — Inspection for Movement	I			
Steering Arm Bolts				I
Steering Relay Assembly			L	
Steering Idler Assembly			L	
Sealed Hub Unit — Inspection	Refer to the unitized wheel-end inspection procedure for inspection intervals.			

[1] Tie rod ends with an anti-tilt style seal require lubrication every 10,000 miles (16 100 km).

[2] If power washers are used during vehicle cleaning operations, lubrication intervals need to be adjusted. Frequent power-washed vehicles will require more frequent lubrication.

I = Inspect

L = Lubricate

4 Inspection

Shock Absorbers

The following conditions may indicate that the shock absorbers should be replaced. If any of these conditions exist, inspect the shock absorbers and repair or replace parts as necessary.

- Uneven tire wear, check balance before replacing the shock absorbers
- Poor ride quality
- Excess vibration
- Premature wear on electrical and cooling system components
- Damaged air springs
- Leaking shock absorber

Inspection

Inspect the shock absorbers for the following conditions. If any of these conditions exist, repair or replace parts as necessary. Figure 4.1.

- Damaged upper or lower mount
- Damaged upper or lower bushing
- Incorrect installation
- Damaged dust tube
- Bent or dented shock absorber body

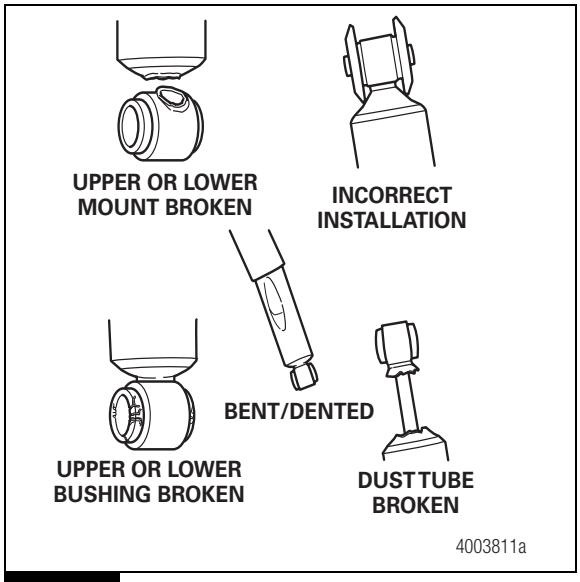


Figure 4.1

Leaking Shock Absorbers

Misting shock absorbers are often misdiagnosed as leaking shock absorbers. Misting is when very small amounts of shock absorber fluid evaporate at high operating temperatures through the shock absorber upper seal. When the mist reaches the cooler outside air, it condenses and forms a film on the outside of the shock absorber body. When mixed with road debris and dust, a grime will often coat the entire body of the shock absorber. Misting is a normal and necessary function of the shock absorber. The evaporating fluid lubricates the seal. A leaking shock absorber will have fluid leaking in streams from the upper seal. Inspect the shock absorbers for leaking when the shock absorber is fully extended. Figure 4.2.

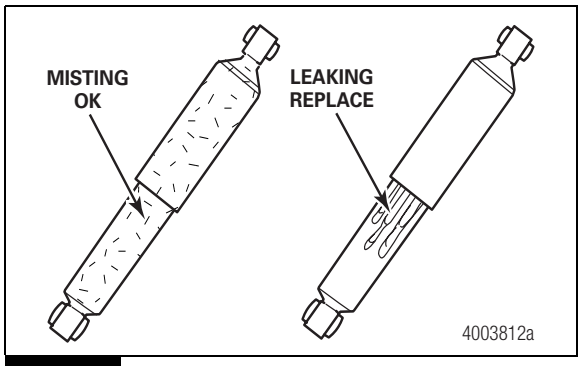


Figure 4.2

Heat Test

Shock absorbers operate at temperatures between ambient and 350°F (177°C). Shock absorbers should be slightly warm or hot after normal use. If poor ride quality exists and you suspect the shock absorber is not operating correctly, perform the following heat test.

1. Drive the vehicle at moderate speeds for at least 15 minutes.
2. Within a few minutes of driving the vehicle, touch the chassis near the shock absorber and then carefully touch each shock absorber body below the dust cover or tube. All shock absorbers should be warmer than the chassis.
   - **If a shock absorber is cooler than the chassis or the shock absorber on the other end of the suspension:** Remove the cooler shock absorber.
3. Shake the shock absorber to inspect it for internal damage. Listen for metal parts rattling inside the shock absorber. Loose metal parts inside the shock absorber can indicate internal damage.

Upper and Lower Control Arm Ball Joints and Bar Pin Bushings

Inspect the upper and lower control arm ball joints before you clean the suspension components. Grease or fluid on the ball joint boots may indicate a leak in the boots.

⚠ WARNING

Park the vehicle on a level surface. Block the wheels to prevent the vehicle from moving. Support the vehicle with safety stands. Do not work under a vehicle supported only by jacks. Jacks can slip and fall over. Serious personal injury and damage to components can result.

1. Park the vehicle on a level surface. Block the wheels to prevent the vehicle from moving.
2. Inspect the four ball joint boots for tears and damage. The boot retaining ring must be in place. Check for grease on the boot. Figure 4.3 and Figure 4.4.
   - **If a boot is damaged or the retaining ring is missing:** Replace the ball joint.

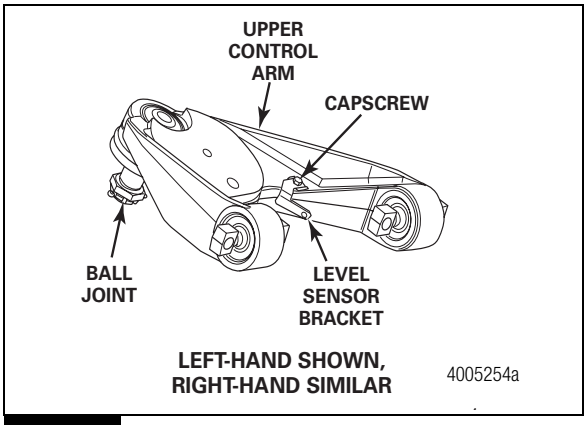


Figure 4.3

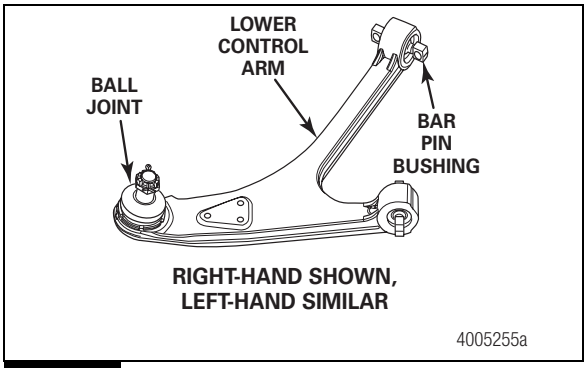


Figure 4.4

3. Inspect the eight bar pin bushings on the left-hand and right-hand upper and lower control arms for cracks in the rubber, wear and looseness. Replace damaged or worn bushings. Figure 4.3 and Figure 4.4.

   Use a two-foot (61 cm) pry bar to check the arm pivot bushings for looseness and wear. Replace the bushings if any free play is detected. Check each location in both axial and radial directions.

   Separation of the elastomer off the bar pin is permissible up to a third (1/3) of the circumference.

   Replacement is also necessary if the following wear characteristics are determined:

   A. Cracks or fracture of the metal parts of the bushing. Figure 4.5.

   B. Plastic deformation of the sheet-metal race

   C. Inadequate bolted connection, i.e., loosened, broken or lost bolt

   D. Damage to the snap ring, snap ring detached from the groove, broken or lost

   - **If damage to the inner housing contour or the snap ring groove is determined during replacement of the elastomeric bearing:** Replace the control arm.

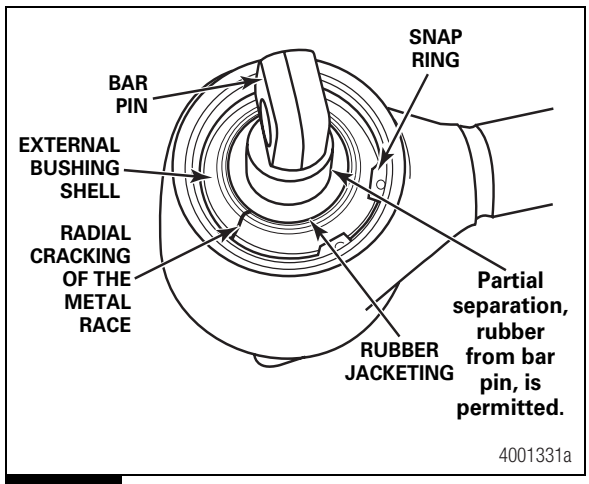


Figure 4.5

4. Check the upper and lower control arms for cracks and damage. Replace worn or damaged control arms.

4 Inspection

5. Use the following procedure to check for ball joint wear.

   A. Using a suitable lift, raise the vehicle so that the front wheels are off the ground. Support the vehicle with safety stands.

   B. Using a dial indicator or suitable measuring instrument, measure the distance between the bottom of the lower control arm and the top of the 80 mm lower ball joint, Dimension A. Figure 4.6.

⚠ CAUTION

Use care when positioning and lifting the pry bar to avoid damaging the boot. Do not allow the bar to slip and cut or tear the boot. Damage to components can result.

   C. Using a pry bar between the knuckle and the lower control arm, lift the ball joint to the maximum limit within the socket. Repeat the measurement made in Step B.

   - **If the difference between the two measurements is greater than 0.079-inch (2 mm):** Replace the ball joint.

   D. Repeat Steps B and C for the 65 mm upper ball joint.

   - **If the difference between the two measurements is greater than 0.059-inch (1.5 mm):** Replace the ball joint.

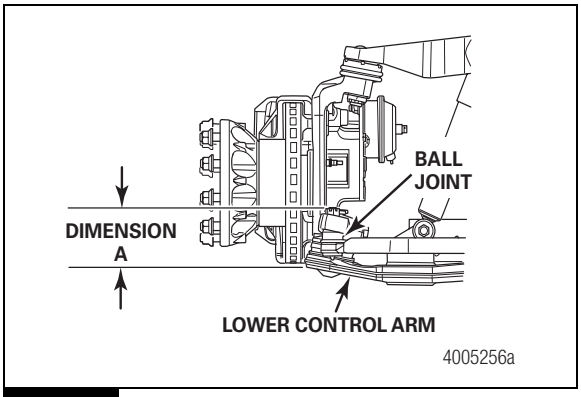


Figure 4.6

Air Springs

⚠ WARNING

Verify that all personnel are clear of the vehicle before you inflate or deflate the air springs. The air suspension system has various pinch points that can cause serious personal injury.

Only use soap and water, methyl alcohol, ethyl alcohol and isopropyl alcohol to clean air springs and air spring components. Do not use organic solvents, open flames, abrasives and direct pressurized steam. Serious personal injury and damage to components can result.

The following items should be inspected when the vehicle is in for periodic maintenance.

1. Always deflate the air springs before you begin service procedures. Do not service the air suspension on a vehicle with the air springs inflated.
2. Inspect the O.D. of the air spring. Check for signs of irregular wear or heat cracking.
3. Inspect the air lines to verify that contact doesn't exist between the air line and the O.D. of the air spring. Air lines can rub a hole in an air spring quickly.
4. Verify that there is sufficient clearance around the entire circumference of the air spring while at its maximum diameter.
5. Inspect the piston for foreign materials.
6. Correct ride height should be maintained. All vehicles with air springs have a specified ride height established by the vehicle manufacturer. This height should be maintained within 1/4-inch (6.35 mm). This dimension can be checked with the vehicle loaded or empty.
7. Leveling valves, or height control valves, ensure that the total air spring system works as required. Clean, inspect and replace, if necessary.
8. Verify that the correct shock absorbers are in place. Inspect the shock absorbers as described in this section. The shock absorber limits the rebound of an air spring and keeps it from overextending.
9. Check the tightness of all mounting hardware (nuts and bolts). If loose, tighten to specification. Do not over-tighten.

Brakes

Inspect the brake pads and rotors for wear. Repair or replace components as necessary. Refer to Technical Bulletin TP-02173, DiscPlus™ DX195 and DX225 Air Disc Brakes. To obtain this publication, refer to the Service Notes page on the front inside cover of this manual.

Steering Assembly

Inspect the tie rods, relay arm, relay rod and idler arm for wear, cracks and damage. Check that no axial or radial end play exists in the relay and idler arm assemblies. Grease the relay and idler arm assemblies per the intervals in Table A. Figure 4.7.

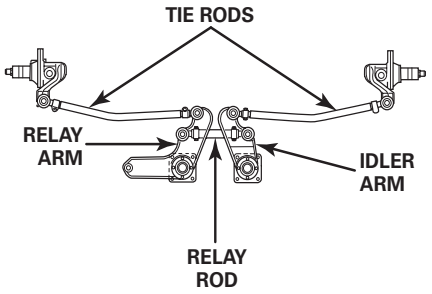


Figure 4.7

Tie Rod and Relay Rod Assemblies

Do not grease the tie rod and relay rod assemblies before you perform the inspection. You may not be able to detect loose or worn tie rod ends during operation. Under normal operating conditions, wear occurs over time. The preload bearings inside each tie rod end provide less resistance, which can affect steering control, front tire wear and other suspension components. Regularly-scheduled inspection and maintenance helps to minimize the effects of tie rod end wear on the vehicle. Refer to Table A for intervals. Figure 4.8.

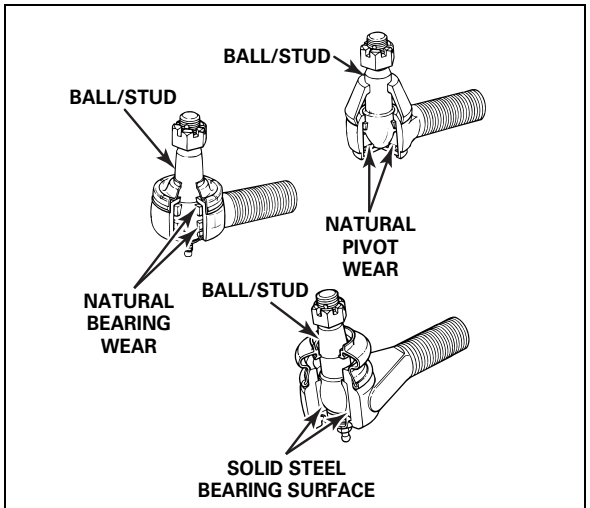


Figure 4.8

1. Park the vehicle on a level surface with the wheels STRAIGHT. Block the wheels to prevent the vehicle from moving. Set the parking brake.
2. Raise the vehicle so that the front wheels are off the ground. Support the vehicle with safety stands. Do not use a jack to support the vehicle.
3. With the engine off, turn the wheels from full left to full right. Return to the straight-ahead position. This step will require more force for vehicles with the power steering off.
4. Check the tie rod boot for cracks, tears or other damage. Also check the boot seals for damage. Replace the entire tie rod end if the boot is damaged or missing. Figure 4.9.

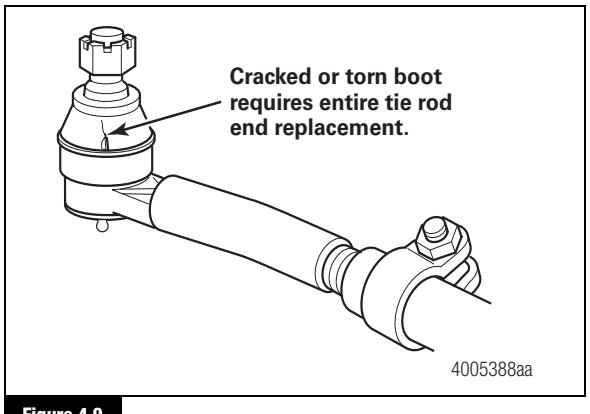


Figure 4.9

4 Inspection

⚠ WARNING

Verify that a cotter pin is installed through the tie rod end, and the tie rod end nut is tightened to the correct torque specification. Replace a missing cotter pin and tighten a loose tie rod end nut. A missing cotter pin or loose tie rod end nut can cause loss of steering control. Serious personal injury and damage to components can result.

5. Check that the tie rod end nut is installed and secured with a cotter pin.
   - **If the cotter pin is missing:** Tighten the tie rod end nut to the correct torque specification. Continue tightening the nut to align the nut slot with the cotter pin hole. Do not back off the nut to obtain the alignment. Install a new cotter pin. Always tighten the tie rod end nut to the specified torque when setting the cotter pin.
6. Verify that the tie rods are the correct length and are within 1/8-inch (3 mm) of each other. The tie rod ends and slotted adjusting sleeve must have the correct engagement with the tie rod. Adjust the tie rod length and tie rod end engagement as necessary. Figure 4.10.
   - **To adjust the length:** Loosen the clamp nut and rotate the slotted sleeve until the appropriate length is achieved. Tighten the clamp nut to 130-150 lb-ft (176-203 N•m).

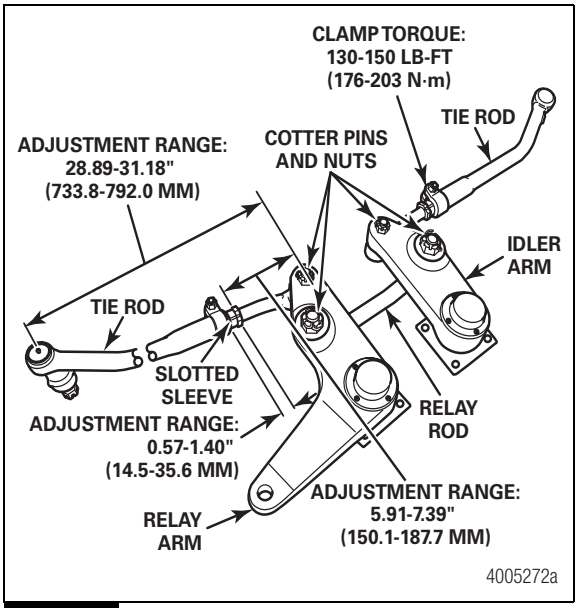


Figure 4.10

7. Check that the grease fittings are installed. Replace damaged grease fittings.
   - **If the tie rod ends are non-greaseable:** Do not install a grease fitting. Figure 4.11.

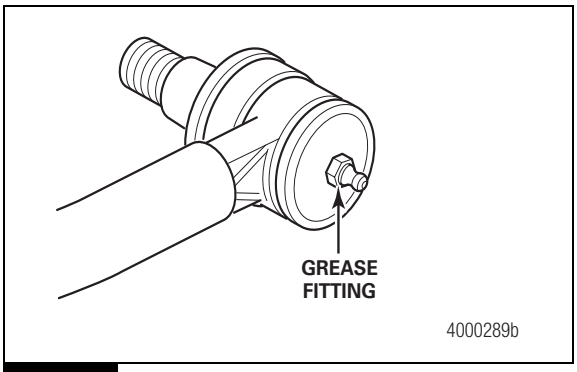


Figure 4.11

8. Position yourself directly below the ball stud socket. Using both hands, grasp the assembly end as close to the socket as possible, no more than six-inches (152.4 mm) from the end.

⚠ CAUTION

Only use your hands to check for movement or looseness of the tie rod assembly. Do not use a crow bar, pickle fork or two-by-four. Do not apply pressure or force to tie rod assembly ends or joints. Do not rock the tires with the vehicle on the ground or with the wheels raised. Damage to components can result.

9. Apply hand pressure of approximately 100 pounds in a vertical PUSH and PULL motion several times. Check for any movement or looseness at both tie rod ends.
   - **If there is any movement in the tie rod assembly:** Replace the tie rod assembly.

⚠ CAUTION

Replace damaged tie rods with original equipment parts. Do not attempt to straighten a bent tie rod. Damage to components can result.

10. Inspect the relay rod, tie rods and clamps for damage. Figure 4.12.
    - **If a tie rod or relay rod is damaged:** Replace it. Use original equipment parts of the same length, diameter and threads.
    - **If the clamps are damaged:** Replace the tie rod.

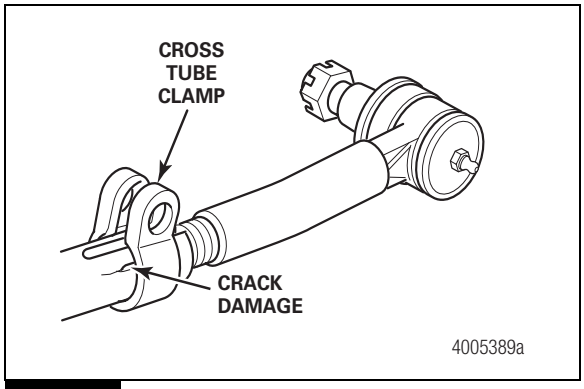


Figure 4.12

11. **Relay Rod Only**

    By hand or using a pipe wrench with jaw protectors to avoid gouging the relay rod, rotate the relay rod toward the FRONT of the vehicle and then toward the REAR. After rotating, center the relay rod between the stop positions.
    - **If the relay rod will not rotate in either direction:** Replace the relay rod.

Department of Transportation Roadside Tie Rod Assembly Replacement Criteria

When the roadside check indicates tie rod end movement of 1/8-inch (3 mm) or more, immediately remove the vehicle from service to replace the tie rod. Figure 4.12.

- **If the roadside check is less than 1/8-inch (3 mm) tie rod end movement:** The vehicle does not need to be immediately removed from a service run. Schedule a major out-of-service inspection and maintenance as soon as possible.

Unitized Wheel Ends

⚠ WARNING

You must follow the unitized wheel-end maintenance and inspection procedures provided in this manual to prevent serious personal injury and damage to components.

Inspection Intervals

You must perform detailed and basic inspections at the following intervals.

Detailed Inspections

Refer to the detailed inspection in this section for procedures.

- After the initial 100,000 miles (160 900 km) of operation or one year, whichever comes first
- After every additional 100,000 miles (160 900 km) of operation or one year, whichever comes first
- At mileages greater than 800,000 miles (1 287 480 km), after every six months or 50,000 miles (80 467 km), whichever comes first

Basic Inspections

After the initial 100,000-mile (160 900 km) detailed inspection, perform a basic inspection at each scheduled preventive maintenance interval, not to exceed 50,000-mile (80 467 km) intervals or one year, whichever comes first.

If the Vehicle is Equipped with ABS

In addition to scheduled preventive maintenance, if driver reports indicate the ABS light has been coming ON, and ABS diagnostics indicate the sensor gap is out-of-adjustment, check for possible wheel-end looseness as the cause.

Tools Required

Basic Inspection

A jack, wheel blocks and safety stands

Detailed Inspection

A dial indicator and a torque wrench with 500 lb-ft (678 N•m) capacity

4 Inspection

Procedures

The unitized wheel end is sealed and greased for life and does not require lubrication. If you disassemble, or attempt to repair or lubricate a unitized wheel-end assembly, you will void the Meritor warranty. The inspection procedures provided in this manual do not instruct you to disassemble the unitized wheel end.

- Unitized wheel ends are not adjustable.
- Do not attempt to set or adjust end play.

Basic Inspection

1. Park the vehicle on a level surface. Block the rear wheels to prevent the vehicle from moving.

⚠ WARNING

Release all air from the air suspension system before you raise the vehicle or remove any components. Pressurized air can cause serious personal injury.

Verify that all personnel are clear of the vehicle before you inflate or deflate the air springs. The air suspension system has various pinch points that can cause serious personal injury.

2. Raise the vehicle so that the front wheels are off the ground. Support the vehicle with safety stands. Do not use a jack to support the vehicle.
3. Visually inspect the unitized wheel end as you rotate the tire and unitized wheel-end assembly. Verify that it rotates smoothly and without noise.

   If a ticking sound is detected during rotation, this does not indicate a hub problem. It is a normal occurrence.

   While rotating the wheel, grasp the brake chamber and steering arm to feel for unitized wheel-end hub vibration.

   - **If the tire and unitized wheel-end assembly does not rotate smoothly, you hear noise such as wheel bearing grind, or feel wheel-end hub vibration during rotation:** Perform a detailed inspection. Refer to Detailed Inspection in this section.
   - **If the wheel end rotates smoothly:** Proceed to Step 4.
4. Grasp the tire and wheel-end assembly at the nine and three o'clock positions. Check for vertical and horizontal movement. With your hands, apply approximately 50 lb (23 kg) of force to the assembly. You should not feel or see any looseness or movement.

   - **If you feel or see any movement or looseness in the tire and wheel-end assembly:** Perform a detailed inspection to determine the cause of the movement, such as worn upper or lower ball joints; worn bar pin bushings; wheel-to-hub-mounting end play; unitized wheel-end hub end play; or a combination of them all. To determine unitized wheel-end hub end play, refer to Detailed Inspection in this section.

   If other suspension components, such as bar pin bushings or ball joints, require inspection or service, refer to the appropriate section of this manual.

Wheel-to-Hub Mounting

Before proceeding with the unitized wheel end inspection, first check the wheel-to-hub mounting.

1. Verify that the wheel is mounted correctly and all wheel-end fasteners and hardware are tightened to the correct specification.
2. Apply the service brake to lock the hub and spindle together. Grasp the tire and wheel-end assembly at the nine and three o'clock positions. Check for vertical and horizontal movement. With your hands, apply approximately 50 lb (23 kg) of force to the assembly. You should not feel or see any looseness or movement.

   - **If you detect movement or looseness:** The upper and lower ball joints and bar pin bushings should be inspected. Refer to the procedure in this section.
   - **If applying the service brake eliminates movement or looseness:** Proceed to Detailed Inspection to determine the unitized wheel-end hub end play.

Detailed Inspection

1. Park the vehicle on a level surface. Block the rear wheels to prevent the vehicle from moving.
2. Raise the vehicle so that the front wheels are off the ground. Support the vehicle with safety stands. Do not use a jack to support the vehicle.

3. Remove the wheel, wheel adapter, rotor and spacer. The outboard and inboard seals of the bearing may purge small amounts of grease that are visible during inspection. This is a normal occurrence. Attach the magnetic base of a dial indicator onto the end of the spindle. Touch the indicator stem against the unitized wheel end mounting face. Figure 4.13. and Figure 4.14.

   It is important to note that the outboard and inboard seals may purge small amounts of grease that are visible during inspection. This is a normal occurrence. Figure 4.15.

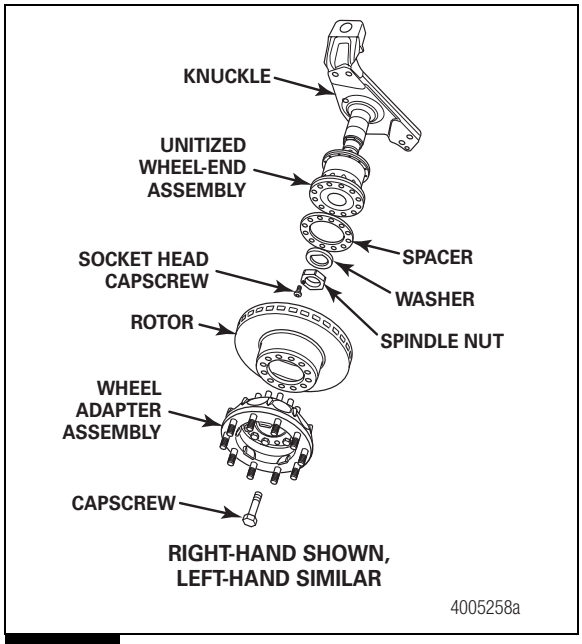


Figure 4.13

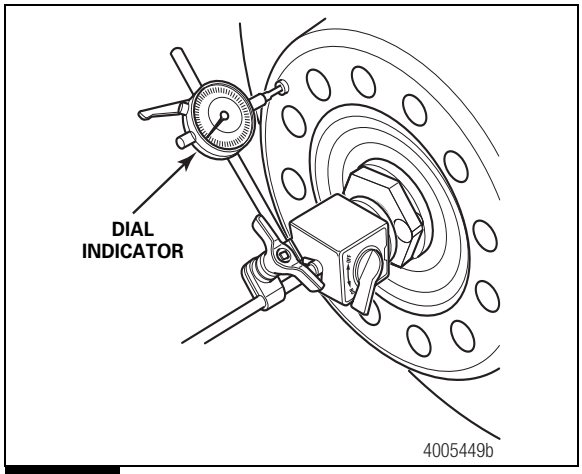


Figure 4.14

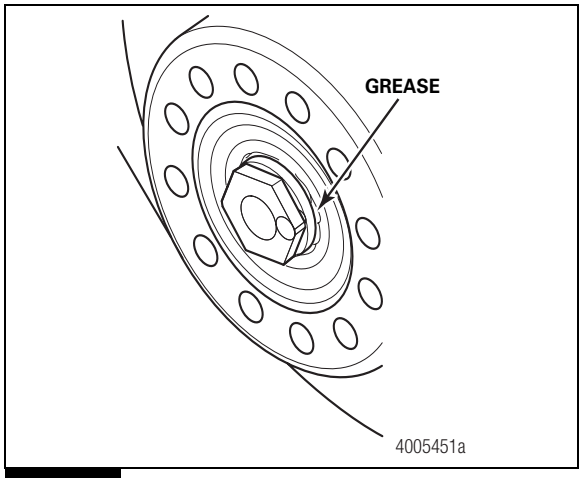


Figure 4.15

4. Set the dial indicator to ZERO. Do not rotate the wheel end. Place your hands at the nine and three o'clock positions.

5. Push the unitized wheel end straight IN. Note the reading. Pull the unitized wheel end straight OUT. Note the reading.

   - **If the total movement of the dial indicator is less than 0.003-inch (0.08 mm):** The inspection is complete. No adjustment is required.
   - **If the total movement of the dial indicator is greater than 0.003-inch (0.08 mm) but less than 0.006-inch (0.15 mm):** Record the measurement in a maintenance log, and perform a basic inspection at the next regularly-scheduled maintenance interval, or not to exceed 50,000 miles (80 467 km), whichever comes first.
   - **If the total movement of the dial indicator is 0.006-inch (0.15 mm) or greater:** Check the spindle nut torque. If the nut meets the torque specification, replace the unitized wheel end.

4 Inspection

6. Verify that the unitized wheel end rotates smoothly and without noise.

   If a ticking sound is detected during rotation, this does not indicate a hub problem. It is a normal occurrence.

   While rotating the unitized wheel end, grasp the brake chamber and steering arm to feel for unitized wheel-end hub vibration.

   - **If the unitized wheel-end assembly does not rotate smoothly, you hear noise such as wheel bearing grind, or feel wheel-end hub vibration during rotation:** Replace the unitized wheel end. You must inspect a replacement hub before you install it. Refer to the replacement unitized wheel-end inspection information in this section.
   - **If the wheel end rotates smoothly:** The inspection is complete. Reinstall the wheel-end equipment. Return the vehicle to service.

Replacement Unitized Wheel-End Inspection

1. Remove the unitized wheel end from the box and place it onto a clean surface.
2. Examine the interior of the unitized wheel end to verify the following.
   A. The inner clip ring has not become dislodged in shipment and is in correct alignment with the inner and outer bearings. The gap between the inner and outer bearing sets and the clip ring must be equal. Figure 4.16.
   B. The gap between the ends of the clip ring must be equal and not exceed 0.25-inch (6 mm). If necessary, adjust by hand. Figure 4.16.
   C. The bearing face must be clean with no seal coating, dirt or dust.

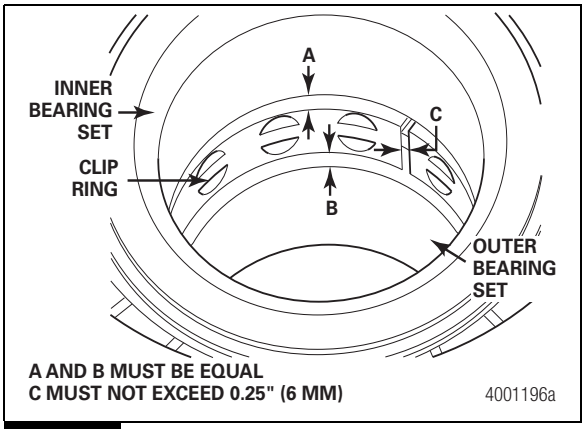


Figure 4.16

3. Examine the exterior of the unitized wheel end to verify the following.
   A. There is no visible damage to the inboard or outboard seals and the bearings have not become unseated. Figure 4.17 and Figure 4.18.
   B. The tone ring is not damaged or bent. Figure 4.18.

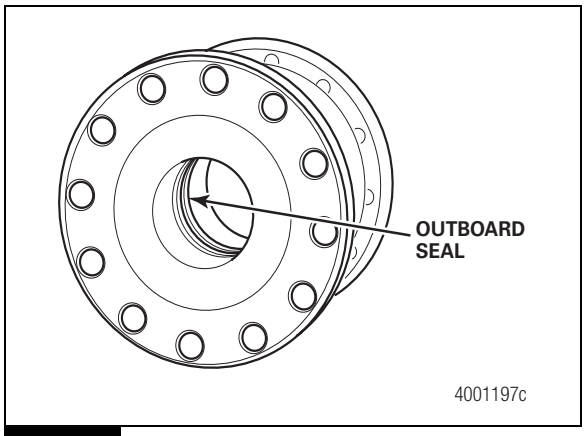


Figure 4.17

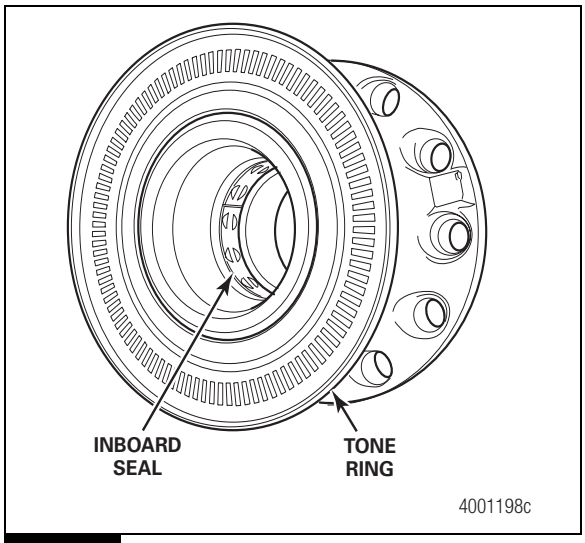


Figure 4.18

Hazard Alert Messages

Read and observe all Warning and Caution hazard alert messages in this publication. They provide information that can help prevent serious personal injury, damage to components, or both.

⚠ WARNING

To prevent serious eye injury, always wear safe eye protection when you perform vehicle maintenance or service.

Release all air from the suspension system before you raise the vehicle or remove any components. Pressurized air can cause serious personal injury.

Park the vehicle on a level surface. Block the wheels to prevent the vehicle from moving. Support the vehicle with safety stands. Do not work under a vehicle supported only by jacks. Jacks can slip and fall over. Serious personal injury and damage to components can result.

Removal

Wheel

1. Park the vehicle on a level surface. Set the parking brake. Block the wheels to prevent the vehicle from moving.
2. Drain the air from the air system.
3. Use a jack to raise the front of the chassis so that the front wheels are off the ground. Support the vehicle with safety stands.
4. Remove the wheel and tire assembly.

Caliper Assembly

Refer to Technical Bulletin TP-02173, DiscPlus™ DX195 and DX225 Air Disc Brakes, for caliper assembly removal procedures. Figure 5.1.

Wheel Adapter and Rotor

⚠ WARNING

Take care when you use lifting devices for service and maintenance procedures. Inspect lifting straps to ensure they are not damaged. Do not subject lifting straps to any shock or drop loading. Serious personal injury and damage to components can result.

1. Support the rotor so it does not fall when you remove the wheel adapter.
2. Remove the 12 capscrews from the wheel adapter. Figure 5.2.
3. Use a lifting device to remove the wheel adapter from the spindle.
4. Use a lifting device to remove the rotor.
5. Remove the spacer.

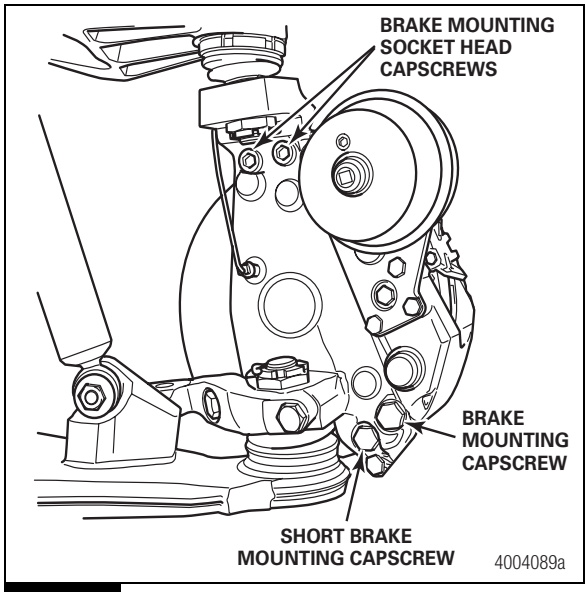


Figure 5.1

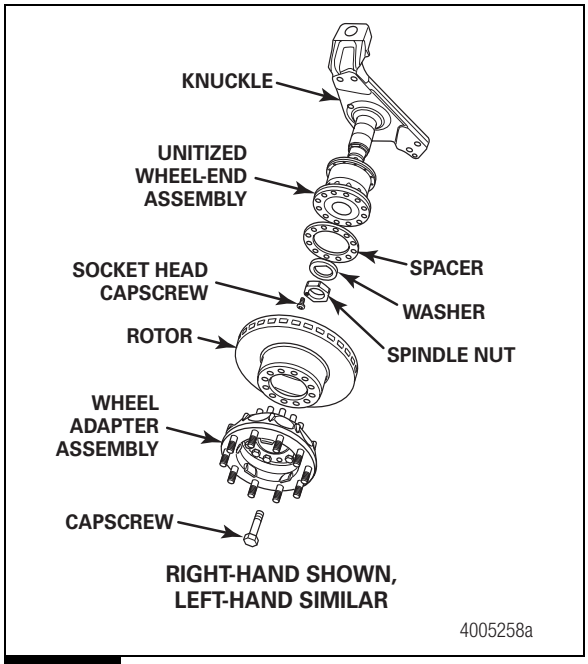


Figure 5.2

5 Removal and Disassembly

Unitized Wheel End

1. Remove the socket head capscrew from the spindle nut. Figure 5.2.
2. Remove the spindle nut from the spindle. The left-hand spindle nut has a right-hand thread and the right-hand spindle nut has a left-hand thread. Figure 5.2.
3. Remove the washer and unitized wheel end from the spindle. Figure 5.2.

Air Spring

⚠ WARNING

Verify that all personnel are clear of the vehicle before you inflate or deflate the air springs. The air suspension system has various pinch points that can cause serious personal injury.

1. Disconnect the air line from the air spring. Remove the two locknuts and washers that secure the air spring to the suspension subframe. Discard the locknuts and washers. Figure 5.3.

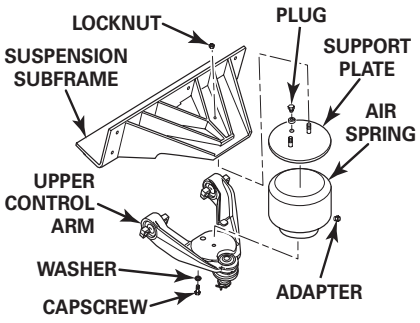


Figure 5.3

2. Remove the capscrew and washer that secure the air spring to the upper control arm. Remove the air spring.

Shock Absorber

⚠ CAUTION

Support the lower control arm before removing the shock absorber. Failure to do so can result in damage to the suspension.

1. Remove the lower shock absorber nut, washer and bolt. Figure 5.4.

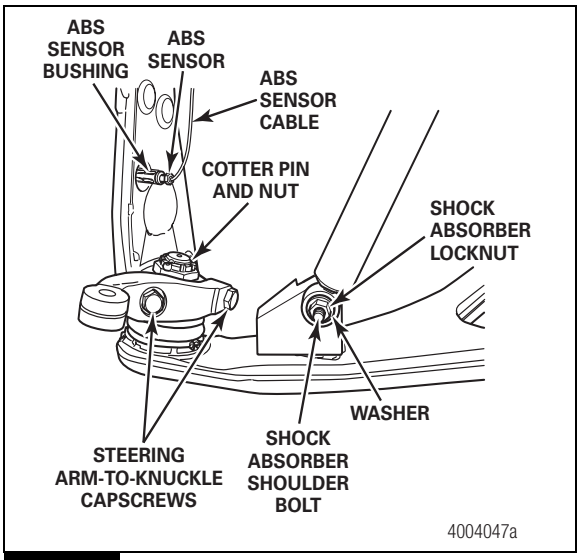


Figure 5.4

2. Remove the upper shock absorber locknut and washer. Remove the shock absorber shoulder bolt and the shock absorber. Discard the locknuts.

Steering Arm and Knuckle

⚠ CAUTION

Do not rotate the knuckle beyond the maximum allowable steer angles. Excessive rotation of the ball joint can damage the ball joints.

Ensure that the air springs are deflated before removing components.

1. Remove the cotter pin and nut that secure the tie rod to the steering arm. Separate the tie rod from the steering arm. Figure 5.5.

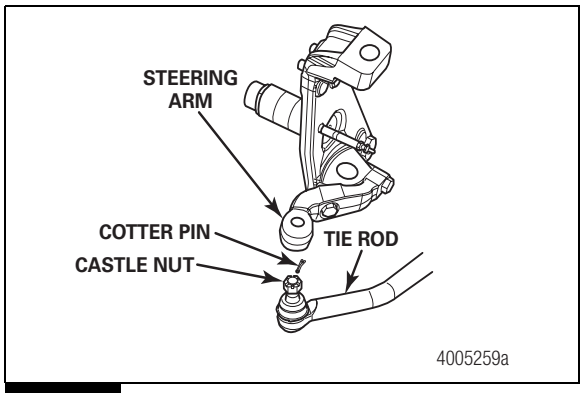


Figure 5.5

2. Remove the two capscrews that secure the steering arm to the knuckle. Remove the steering arm. Figure 5.4.
3. Remove the ABS sensor and ABS sensor bushing from the knuckle. Figure 5.4.
4. Support the knuckle so it does not fall during the following removal steps.
5. Remove the cotter pin and nut that secure the knuckle to the lower control arm ball joint. Figure 5.4.
6. Remove the cotter pin and nut that secure the knuckle to the upper control arm ball joint. Figure 5.6.

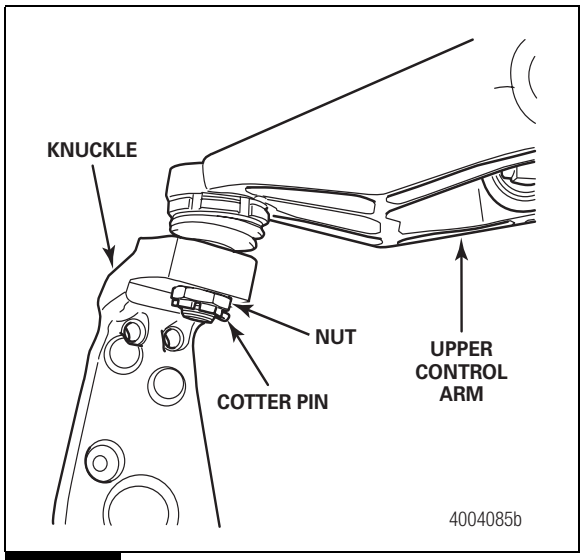


Figure 5.6

7. Use the correct tool to separate the upper control arm ball joint stud from the knuckle. Refer to Figure 10.1 in Section 10.
8. With the knuckle supported, use the correct tool to separate the lower ball joint stud from the knuckle. Refer to Figure 10.2 in Section 10. Remove the knuckle.

Upper and Lower Control Arm

1. Support the lower control arm. Figure 5.7.

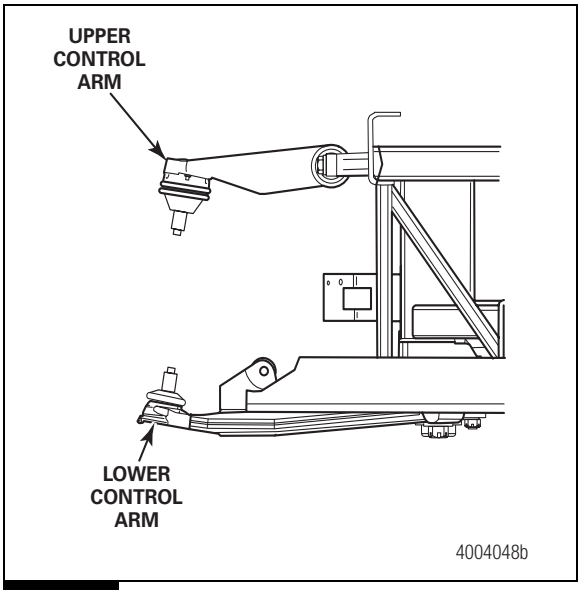


Figure 5.7

2. Remove the three capscrews that secure the lower shock absorber bracket to the lower control arm. Remove the lower shock absorber bracket. Figure 5.8.

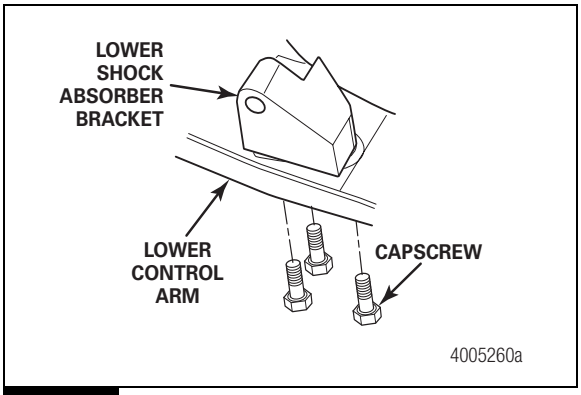


Figure 5.8

5 Removal and Disassembly

3. Remove the four capscrews and washers that secure the lower control arm to the suspension subframe. Remove the lower control arm. Figure 5.9.

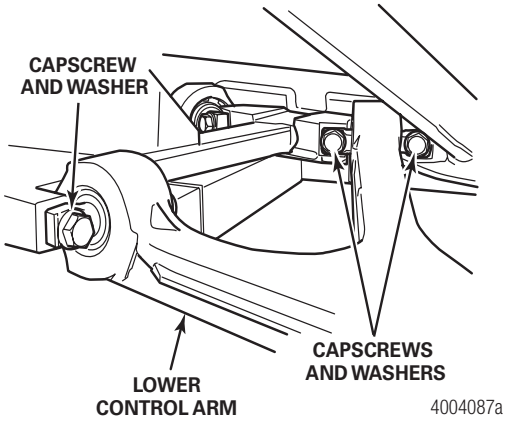


Figure 5.9

4. Support the upper control arm. Figure 5.3.
5. Remove the four capscrews and washers that secure the upper control arm to the suspension subframe. Remove the upper control arm. Figure 5.10.

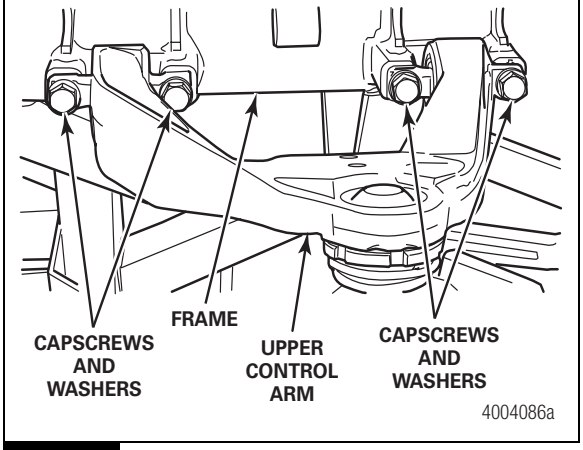


Figure 5.10

Disassembly

Upper and Lower Control Arms

Ball Joints

1. Place the upper control arm into a suitable holding fixture with the ball joint stud facing UP. Figure 5.11.

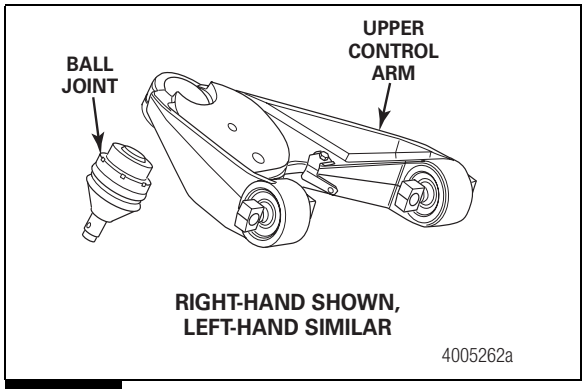


Figure 5.11

2. Bend the flange on the ball joint up from the depression on the upper control arm. Use a 65 mm spanner socket to unscrew the ball joint from the threaded bore in the upper control arm. Refer to Figure 10.3 in Section 10.
3. Place the lower control arm into a suitable holding fixture with the ball joint stud facing UP. Figure 5.12.

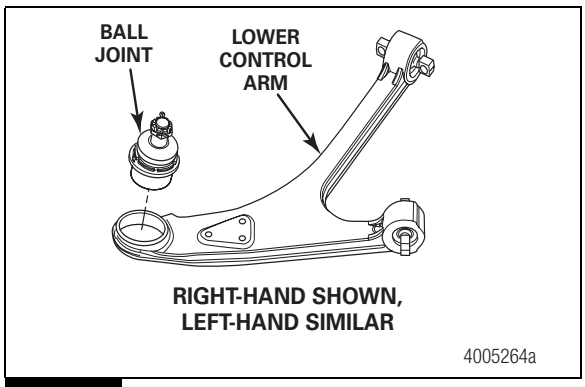


Figure 5.12

4. Bend the flange on the ball joint up from the depression on the lower control arm. Use an 80 mm spanner socket to unscrew the ball joint from the threaded bore in the lower control arm. Refer to Figure 10.4 in Section 10.

Pin Bushings

1. Remove the snap ring from the outer bushing bore. Figure 5.13 and Figure 5.14.

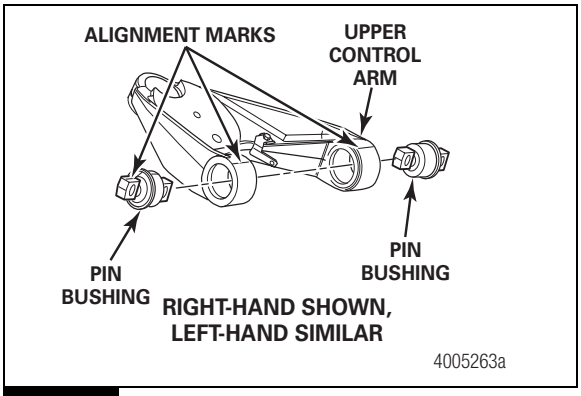


Figure 5.13

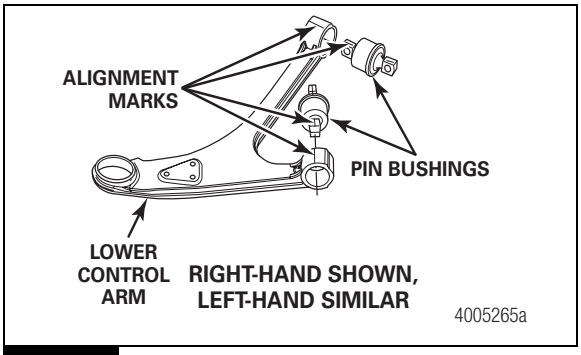


Figure 5.14

2. On the control arm, mark the position of the bushing's bar pin ears. You will need the mark to correctly align the bar pin ears when you install the new bushing.

⚠ WARNING

Observe all warnings and cautions provided by the press manufacturer to avoid damage to components and serious personal injury.

3. Place the control arm into a press with the pin bushing supported on a press plate. Pin bushings are removed from the CENTER OUT on upper control arms and from the CENTER IN on lower control arms, so it may be difficult to support the control arm in a press because of interference from the opposite pivot with the press ram. To avoid interference, position the control arm so that the control arm is pressed from the bushing.
4. Use suitable adapters to press the bar pin bushing from the control arm.

Removal

Steering Assembly

1. If necessary, remove the cotter pins and nuts that secure the tie rods to the steering, idler and relay arms. Separate the tie rods from the steering, idler and relay arms. Figure 5.15.

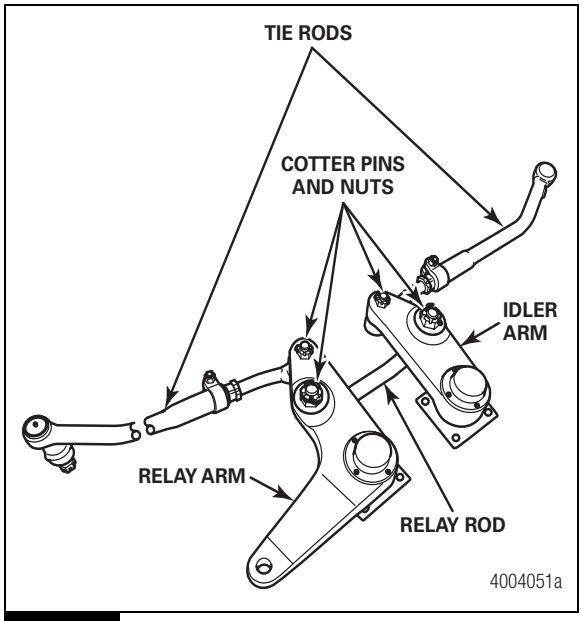


Figure 5.15

2. Loosen, but do not remove, the eight capscrews that secure the idler and relay arm assemblies to the suspension subframe. Lower the idler and relay arm assemblies so that the relay rod clears the subframe. This will provide more room to work when removing the castle nuts. Figure 5.16.

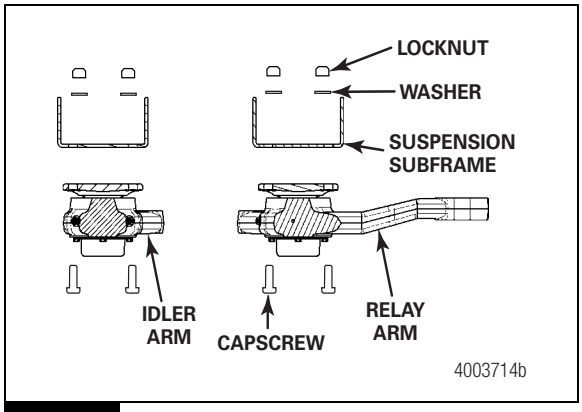


Figure 5.16

5 Removal and Disassembly

3. Remove the cotter pins and nuts that secure the relay rod to the idler and relay arms. Remove the relay rod. Figure 5.15.
4. Remove the four locknuts, capscrews and washers that secure the relay arm assembly to the suspension subframe. Remove the relay arm assembly. Figure 5.16.
5. Remove the four locknuts, capscrews and washers that secure the idler arm assembly to the suspension subframe. Remove the idler arm assembly. Figure 5.16.
6. Place the steering assembly components on a workbench.

Disassembly

Idler Arm and Relay Arm

1. Remove the capscrews and lock washers from the cover on the idler arm. Remove the cover. Figure 5.17.

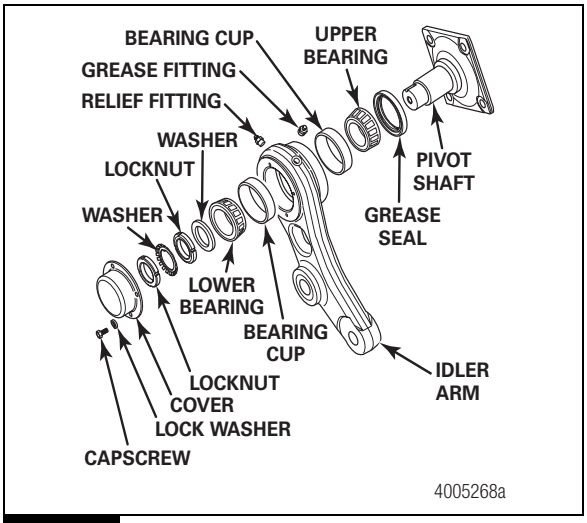


Figure 5.17

2. Use a spanner socket to remove the outer locking nut, tabbed lock washer, inner locking nut and washer from the pivot shaft. Refer to Section 10.
3. Remove the pivot shaft.
4. Remove the lower bearing cone.
5. Remove the grease seal from the idler arm.
6. Remove the upper bearing cone from the idler arm.
7. Remove the upper and lower bearing cups from the idler arm.
8. Repeat the procedure to disassemble the relay arm. Figure 5.18.

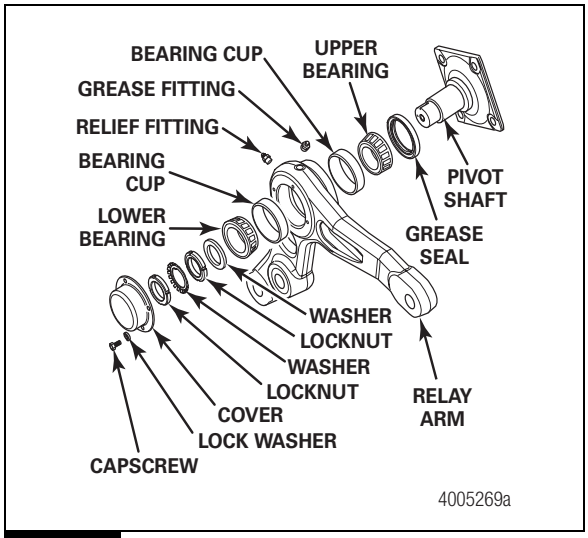


Figure 5.18

Hazard Alert Messages

Read and observe all Warning and Caution hazard alert messages in this publication. They provide information that can help prevent serious personal injury, damage to components, or both.

⚠ WARNING

To prevent serious eye injury, always wear safe eye protection when you perform vehicle maintenance or service.

Solvent cleaners can be flammable, poisonous and cause burns. Examples of solvent cleaners are carbon tetrachloride, and emulsion-type and petroleum-base cleaners. Read the manufacturer's instructions before using a solvent cleaner, then carefully follow the instructions. Also follow the procedures below.

- **Wear safe eye protection.**
- **Wear clothing that protects your skin.**
- **Work in a well-ventilated area.**
- **Do not use gasoline, or solvents that contain gasoline. Gasoline can explode.**
- **You must use hot solution tanks or alkaline solutions correctly. Read the manufacturer's instructions before using hot solution tanks and alkaline solutions. Then carefully follow the instructions.**

⚠ CAUTION

Do not use hot solution tanks or water and alkaline solutions to clean ground or polished parts. Damage to parts can result.

Clean, Dry and Inspect Parts

Ground or Polished Parts

Use a cleaning solvent to clean the ground or polished parts and surfaces. Kerosene or diesel fuel can be used for this purpose. DO NOT USE GASOLINE.

Do NOT clean ground or polished parts in a hot solution tank or with water, steam or alkaline solutions. These solutions will cause corrosion of the parts.

Rough Parts

Rough parts can be cleaned with the ground or polished parts. Rough parts also can be cleaned in hot solution tanks with a weak alkaline solution. Parts must remain in the hot solution tanks until they are completely cleaned and heated.

Dry Cleaned Parts

Parts must be dried immediately after cleaning. Dry parts with clean paper or rags, or compressed air. Do not dry bearings by spinning with compressed air.

Prevent Corrosion on Cleaned Parts

Apply a light oil to cleaned and dried parts that are not damaged and are to be immediately assembled. Do NOT apply oil to the brake linings or the brake rotors.

If the parts are to be stored, apply a good corrosion preventative to all surfaces. Do NOT apply the material to the brake linings or the brake rotors. Store the parts inside special paper or other material that prevents corrosion.

All tapered joints must be clean and dry with no lubrication or corrosion preventative applied to the mating surfaces.

Inspection

⚠ WARNING

Use only dye penetrant inspection techniques on unitized wheel-end hub units. Be careful not to get penetrant fluids into the bore of the hub unit. Do not use fluid immersion-based crack inspection techniques. The fluids can enter the joint between the inner bearing cones through the bore of the hub unit and damage the lubricant. Serious personal injury and damage to components can result.

Carefully inspect all disassembled parts before assembly. Inspect and replace any parts that are worn, cracked or damaged. Check for cracks with dye penetrant, magnetic flux or fluorescent particle testing methods.

Steering Arm and Knuckle

Inspect the knuckle and arm and replace any worn or damaged parts.

1. Inspect the upper and lower tapered bores in the knuckle for wear and damage. Inspect the taper on the ball joint studs.
2. Inspect the bearing contact surfaces and spindle for wear and damage.
3. Inspect the steering arm for cracks and the tapered bores in the steering arm for wear and damage. Inspect the taper on the tie rod ends.

6 Prepare Parts for Assembly

Tie Rod Grease Fittings

1. If a grease fitting is missing, install a new one. Figure 6.1.

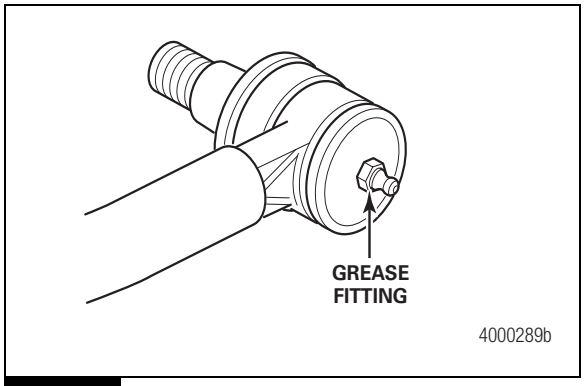


Figure 6.1

2. Tighten all grease fittings to 25 lb-in (2.8 N•m). Figure 6.2.

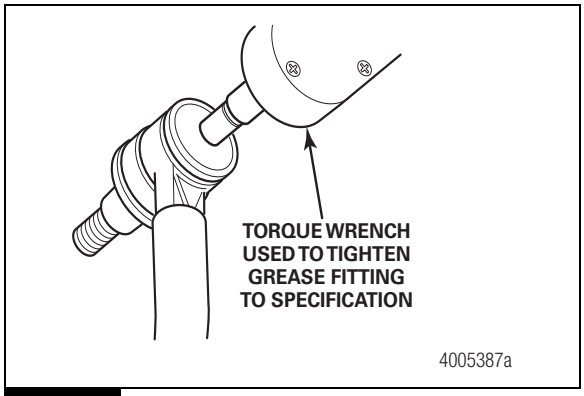


Figure 6.2

Hazard Alert Messages

Read and observe all Warning and Caution hazard alert messages in this publication. They provide information that can help prevent serious personal injury, damage to components, or both.

⚠ WARNING

To prevent serious eye injury, always wear safe eye protection when you perform vehicle maintenance or service.

Take care when you use Loctite® adhesive to avoid serious personal injury. Read the manufacturer's instructions before using this product. Follow the instructions carefully to prevent irritation to the eyes and skin.

Assembly

Upper and Lower Control Arms

Pin Bushings

1. Place the housing support sleeve onto a suitable press. Place the control arm onto the housing support sleeve with the bore facing UP. Refer to Section 10 for tool drawings. Figure 7.1, Figure 7.2 and Figure 7.3.

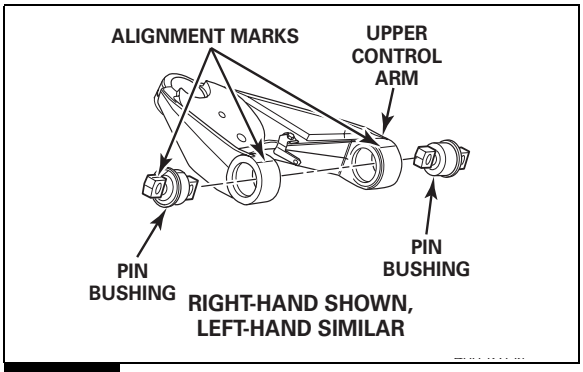


Figure 7.1

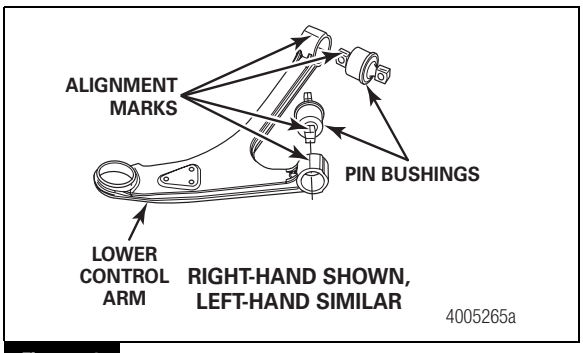


Figure 7.2

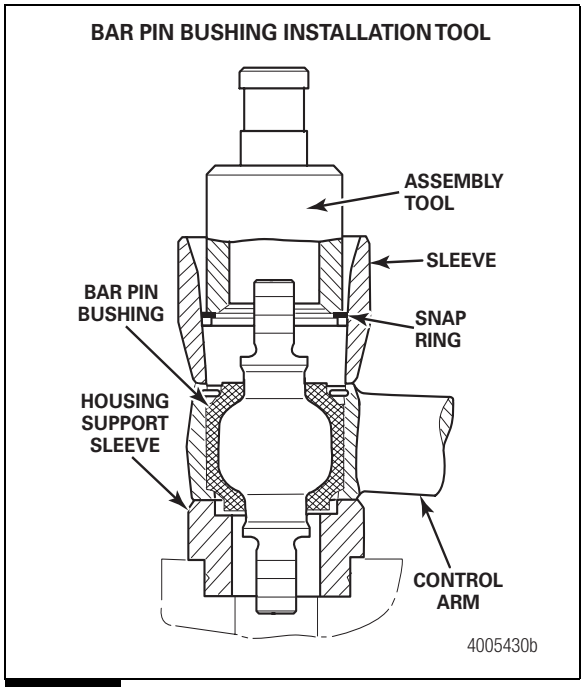


Figure 7.3

2. Place a new pin bushing into the control arm bore. Align the bar pin ears with the alignment marks on the control arm.
3. Place the installation sleeve over the pin bushing.
4. Place the assembly tool and the pin bushing snap ring through the installation sleeve.
5. Use a press to apply force on the assembly tool until the snap ring is seated in the housing.
6. Verify that the snap ring is fully seated.

7 Assembly and Installation

Ball Joints

1. Check the bore for deformed threads, burrs, cracks and damage. Replace as necessary. Figure 7.4 and Figure 7.5.

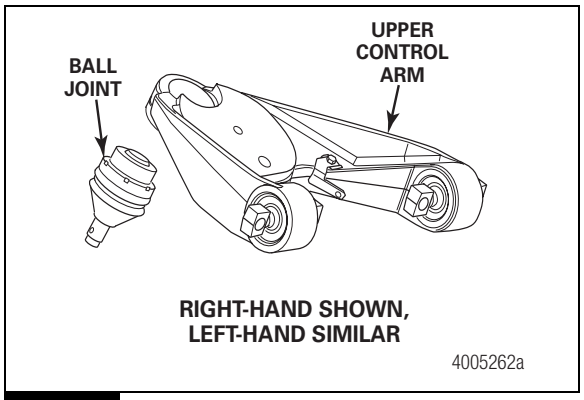


Figure 7.4

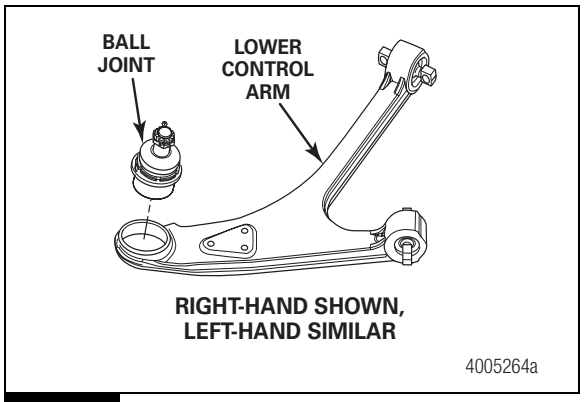


Figure 7.5

2. Clean the bore threads.
3. Apply Loctite® 243 threadlocker to the ball joint threads.
4. Install a new ball joint into the control arm. The upper control arm uses a 65 mm ball joint. The lower control arm uses an 80 mm ball joint.
5. Use the correct spanner socket to tighten the ball joint into the control arm bore to 1033-1106 lb-ft (1400-1500 N•m). Refer to Section 10.
6. Peen the ball joint lip into the adjacent recess on the control arm. Figure 7.6 and Figure 7.7.

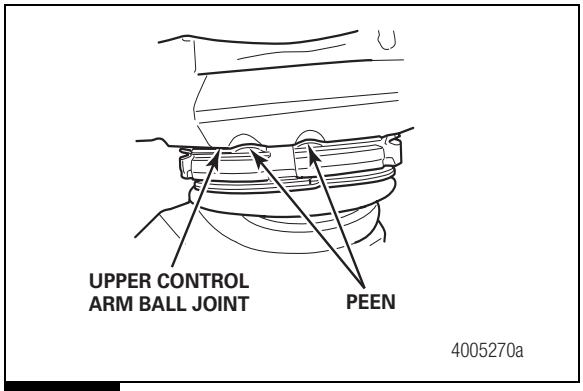


Figure 7.6

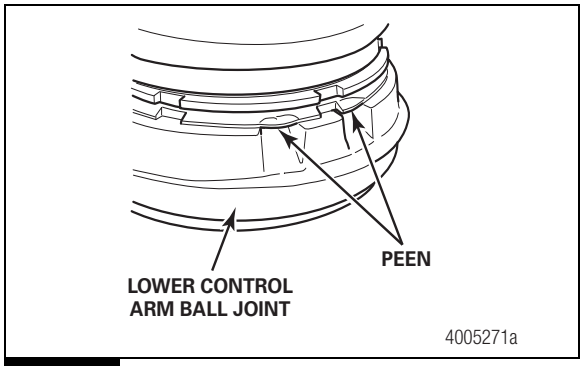


Figure 7.7

Installation

Upper and Lower Control Arm

1. Apply Loctite® 271 adhesive to the internal threads of the upper and lower control arm mounting brackets on the subframe.
2. Position the upper control arm onto the frame. Support the upper control arm. Install the four capscrews and washers that secure the upper control arm to the frame. The capscrews will be M18 or M20 depending on the suspension. Tighten the M18 capscrews to 225-273 lb-ft (305-370 N•m). Tighten the M20 capscrews to 369-480 lb-ft (500-650 N•m). Figure 7.8.

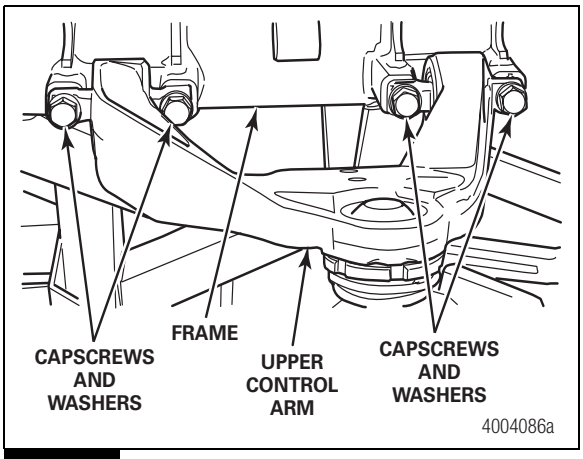


Figure 7.8

3. Position the lower control arm onto the frame. Support the lower control arm. Install the four capscrews and washers that secure the lower control arm to the frame. The capscrews will be M18 or M20 depending on the suspension. Tighten the M18 capscrews to 225-273 lb-ft (305-370 N•m). Tighten the M20 capscrews to 369-480 lb-ft (500-650 N•m). Figure 7.9.

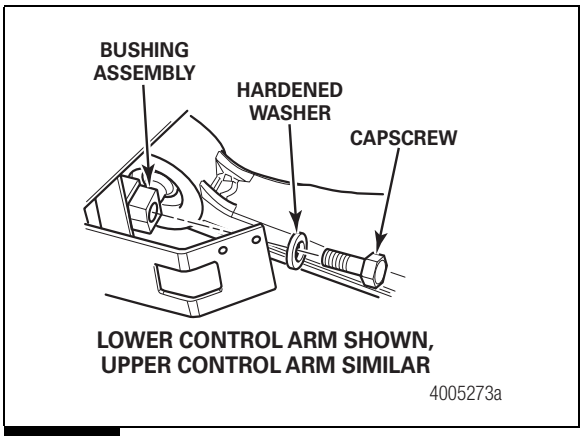


Figure 7.9

4. Position the lower shock absorber bracket onto the lower control arm. Install the three capscrews that secure the lower shock absorber bracket to the lower control arm. Tighten the capscrews to 180-188 lb-ft (245-255 N•m). Figure 7.10.

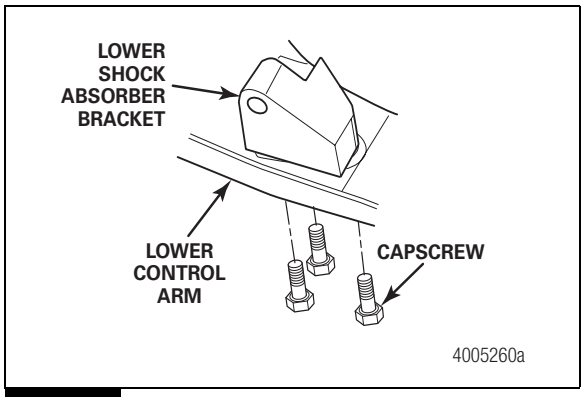


Figure 7.10

Steering Arm and Knuckle

1. Position the knuckle onto the lower control arm ball joint stud. Insert the upper control arm ball joint stud into the knuckle.
2. Install the nut that secures the knuckle to the lower control arm ball joint. Tighten the nut to 922-959 lb-ft (1250-1300 N•m). Continue to tighten the nut to align the nut slot with the cotter pin hole. Do not back off the nut to align the nut slot with the cotter pin hole. Install the cotter pin into the nut. Figure 7.11.

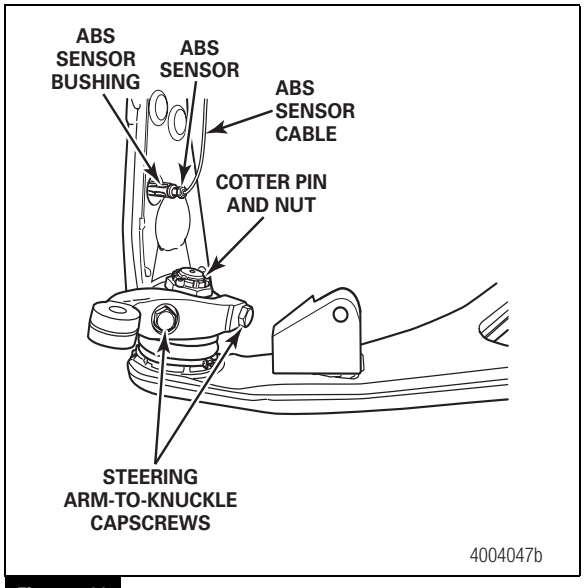


Figure 7.11

7 Assembly and Installation

3. Install the nut that secures the upper control arm ball joint to the knuckle. Tighten the nut to 553-590 lb-ft (750-800 N•m). Continue to tighten the nut to align the nut slot with the cotter pin hole. Do not back off the nut to align the nut slot with the cotter pin hole. Install the cotter pin into the nut. Figure 7.12.

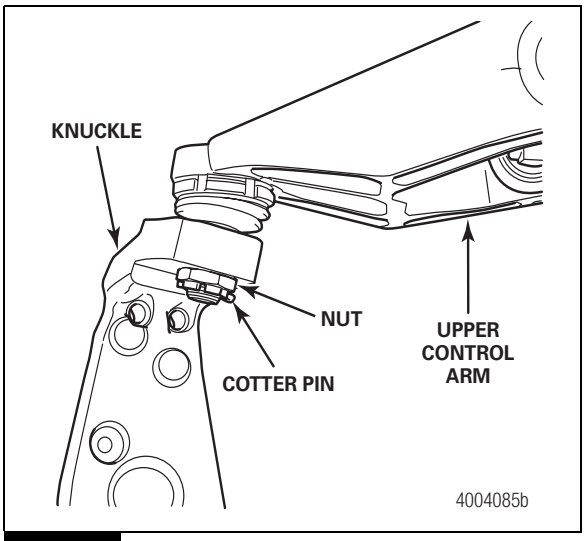


Figure 7.12

4. Position the steering arm onto the knuckle. Apply Loctite® 242 threadlocker, Meritor specification 2297-W-5431, to the two capscrews. Install the two capscrews that secure the steering arm to the knuckle. Tighten the capscrews to 406-428 lb-ft (550-580 N•m). Figure 7.11.

5. Install the ABS sensor bushing and ABS sensor into the knuckle using the procedure in technical bulletin TP-02102, Installation Instructions for Meritor WABCO Wheel Speed Sensor Replacement Kit. For service instructions for ABS braking systems, refer to Maintenance Manual 28, Anti-Lock Braking Systems (ABS) for Trucks, Tractors and Buses, For C Version ECUs; and Maintenance Manual 30, Anti-Lock Braking Systems (ABS) for Trucks, Tractors and Buses, For D Version ECUs. To obtain these publications, refer to the Service Notes page on the front inside cover of this manual. Figure 7.11.

Unitized Wheel End

Inspect the unitized wheel end according to the replacement unitized wheel end inspection procedure in Section 4.

1. Clean the unitized wheel end inner bore and spindle with a clean dry rag. Do not apply any solvent.
2. Check the bore of the unitized wheel end for any obstructions and check the spindle for any nicks or burrs.

⚠ WARNING

Do not apply anti-seize or anti-fretting compound to the spindle threads. These compounds decrease a fastener assembly's capability to maintain clamp load, which can cause wheels to loosen and separate from the vehicle. Serious personal injury and damage to components can result.

3. Coat the inside of the unitized wheel end with anti-seize compound. Verify that the inner and outer bearing races are covered. Do not apply anti-seize or anti-fretting compound to the spindle or threads. Remove any anti-seize or anti-fretting compound that may have dripped onto the spindle threads.

⚠ CAUTION

Align the unitized wheel end STRAIGHT onto the spindle. Do not allow the assembly to misalign and contact the spindle threads. Bearing damage can occur that requires replacement of the entire unitized wheel end.

4. Carefully align the unitized wheel end bore with the spindle and slide the unitized wheel end STRAIGHT onto the spindle. Figure 7.13.
   - **If the unitized wheel end does not slide on easily:** Do not force it onto the spindle. The unitized wheel end can become jammed on the spindle if it is not aligned correctly with the spindle.
   - **If the unitized wheel end becomes jammed on the spindle:** Carefully remove the unitized wheel end from the spindle so that the inner bearings do not disassemble or loosen from the unitized wheel end.

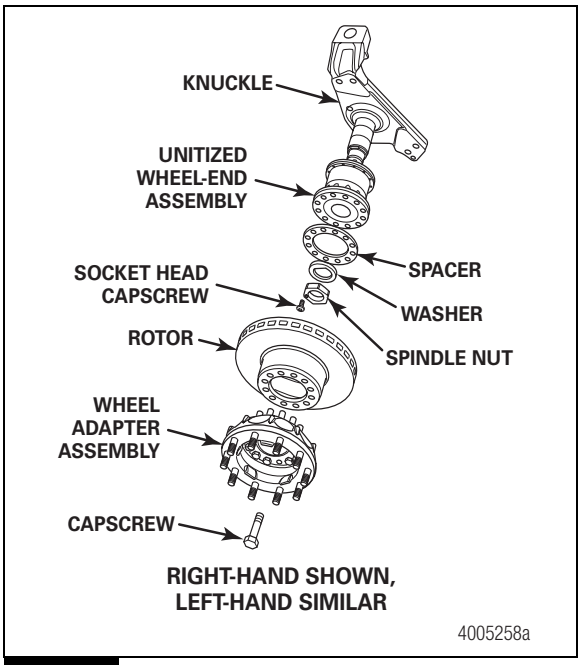


Figure 7.13

5. Install the "D" washer and locknut onto the spindle. The left-hand spindle nut has a right-hand thread and the right-hand spindle nut has a left-hand thread. Tighten the locknut to 406-420 lb-ft (550-570 N•m).

6. Apply Loctite® 242 threadlocker, Meritor specification 2297-W-5431, to the socket head capscrew. Install the socket head capscrew into the locknut. Tighten the capscrew to 22-26 lb-ft (30-35 N•m).

Wheel Adapter and Rotor

⚠ WARNING

Take care when you use lifting devices for service and maintenance procedures. Inspect lifting straps to ensure they are not damaged. Do not subject lifting straps to any shock or drop loading. Serious personal injury and damage to components can result.

1. Install the spacer into the rotor.
2. Use a lifting device to position the rotor onto the wheel bearing assembly.
3. Use a lifting device to position the wheel adapter onto the wheel bearing assembly.
4. Apply Loctite® 242 threadlocker, Meritor specification 2297-W-5431, to the 12 capscrews. Install the capscrews into the wheel adapter. Tighten the capscrews to 321-339 lb-ft (435-460 N•m). Figure 7.13.

Caliper Assembly

1. Position the caliper assembly onto the rotor.
2. Install the four brake mounting capscrews. Tighten the capscrews to 402-494 lb-ft (545-670 N•m). You must install the short capscrew into the correct position. Figure 7.14.

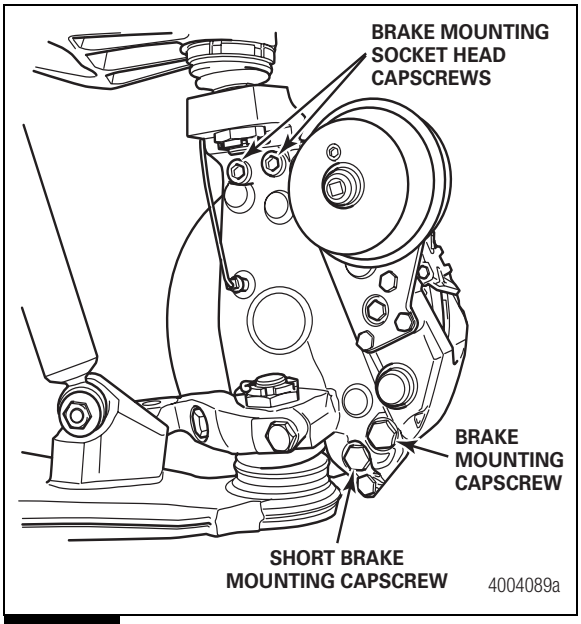


Figure 7.14

3. Remove the plug from the hole in the brake chamber. Connect the air line to the brake chamber.
4. Adjust the brake. Refer to Technical Bulletin TP-02173, DiscPlus™ DX195 and DX225 Air Disc Brakes. To obtain this publication, refer to the Service Notes page on the front inside cover of this manual.
5. Install the tire and wheel assembly onto the wheel adapter. Tighten the wheel lug nuts to specification. Refer to the vehicle manufacturer's manual for the tightening sequence and the wheel lug nut torque specifications.

7 Assembly and Installation

Air Spring

1. Position the air spring onto the upper control arm. Install the bolt and washer that secure the air spring to the upper control arm. Tighten the bolt to 96-100 lb-ft (130-135 N•m). Figure 7.15.

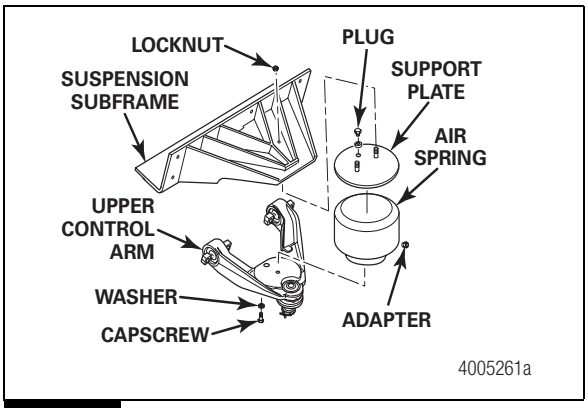


Figure 7.15

2. Install the two nuts and washers that secure the air spring support plate to the subframe. Tighten the nuts to 69-87 lb-ft (94-118 N•m). Install the adapter and tighten it to 30-33 lb-ft (40-44 N•m). Connect the air line to the air spring adapter. Install the plug and tighten it to 41-44 lb-ft (55-60 N•m). Figure 7.15.

Shock Absorber

1. Position the shock absorber and install the upper shock absorber shoulder bolt, nut and washer. Tighten the nut to 270-350 lb-ft (366-474 N•m). Figure 7.16.
2. Install the lower shock absorber shoulder bolt, nut and washer. Tighten the nut to 270-350 lb-ft (366-474 N•m). Figure 7.17.

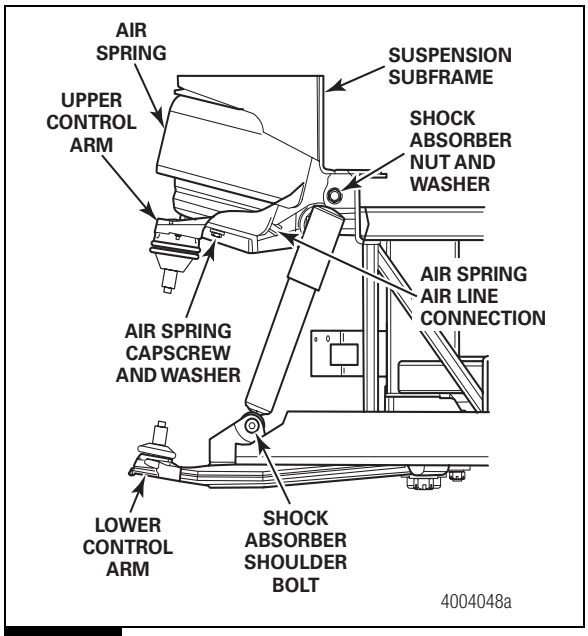


Figure 7.16

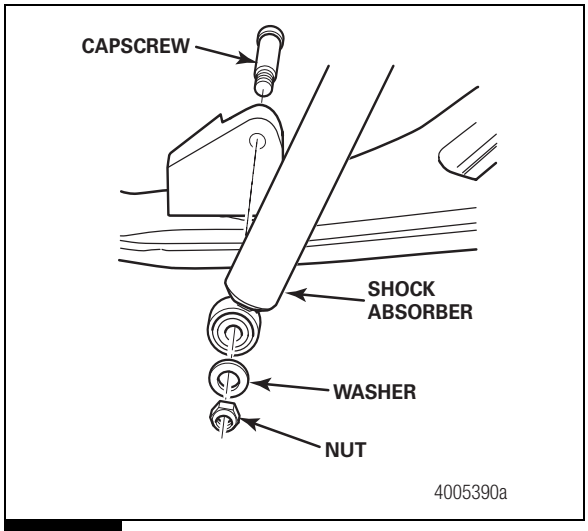


Figure 7.17

Assembly

Idler Arm and Relay Arm

1. Install the upper and lower bearing cups into the idler arm. Figure 7.18.

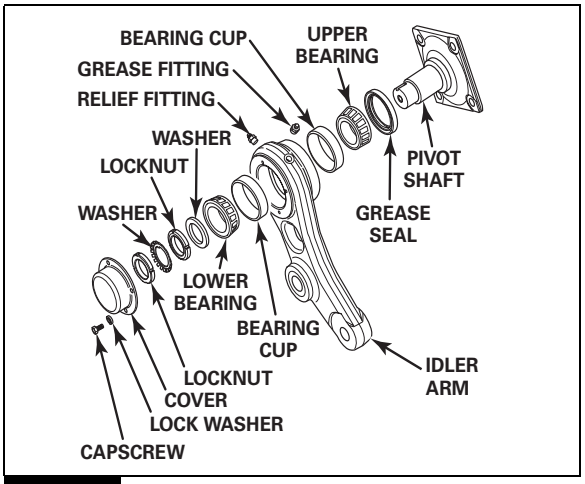


Figure 7.18

2. Pack both bearing cones with grease. Use grease that meets the specifications shown in Table D.
3. Install the upper bearing cone into the upper bearing cup in the idler arm.
4. Install the grease seal 0.118-inch (3 mm) into the idler arm. Figure 7.19.

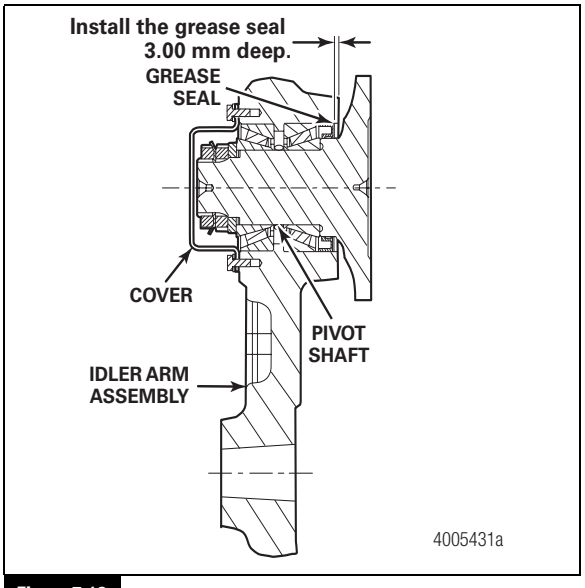


Figure 7.19

5. Install the pivot shaft into the idler arm.
6. Install the lower bearing cone into the lower bearing cup in the idler arm.
7. Install the washer onto the pivot shaft.
8. Install the inner locknut onto the pivot shaft. Use a spanner socket to tighten the locknut to 74 lb-ft (100 N•m). Refer to Section 10.
9. Rotate the idler arm a minimum of five times, plus and minus 1/2 turn. Tighten the locknut to 74 lb-ft (100 N•m).
10. Rotate the idler arm a minimum of five times, plus and minus 1/2 turn. Loosen the inner locknut.
11. Use a spanner socket to tighten the inner locknut to 37 lb-ft (50 N•m). Refer to Section 10.
12. Install the tabbed lock washer onto the pivot shaft.
13. Install the outer locknut onto the pivot shaft. Use a spanner socket to tighten the outer locknut to 37 lb-ft (50 N•m). Refer to Section 10.
14. Continue to tighten the outer locknut until one slot of the locknut aligns with the lock washer tab.
15. Bend the lock washer tab into the outer locknut slot.
16. Hold the outer locknut and use a spanner socket to tighten the inner locknut against the outer locknut to 166-202 lb-ft (225-275 N•m). Refer to Section 10.
17. Apply Loctite® Gasket Maker 518 sealant to the idler arm surface where the cover contacts the arm.
18. Install the cover, lock washers and capscrews onto the idler arm. Tighten the capscrews to 7-9 lb-ft (10-12 N•m).
19. Fill the idler arm with grease until grease purges from the relief fitting.

7 Assembly and Installation

20. Repeat the procedure to assemble the relay arm. Figure 7.20.

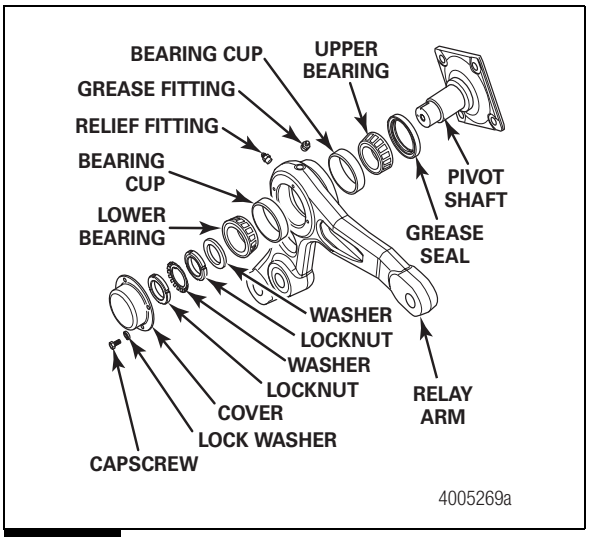


Figure 7.20

Installation

Steering Assembly

⚠ WARNING

Before you perform the assembly procedures, thoroughly clean the mounting surfaces. Rust and oil decrease a fastener assembly's capability to maintain clamp load. Serious personal injury and damage to components can result.

1. Clean any rust or oil from the subframe in the area under the eight washers. Figure 7.21.

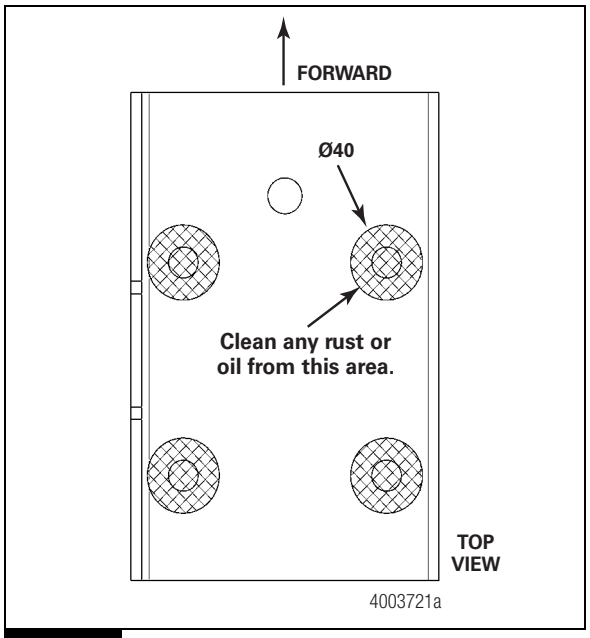


Figure 7.21

2. Clean any rust or oil from the subframe in the area that the relay and idler shaft are installed. Figure 7.22.

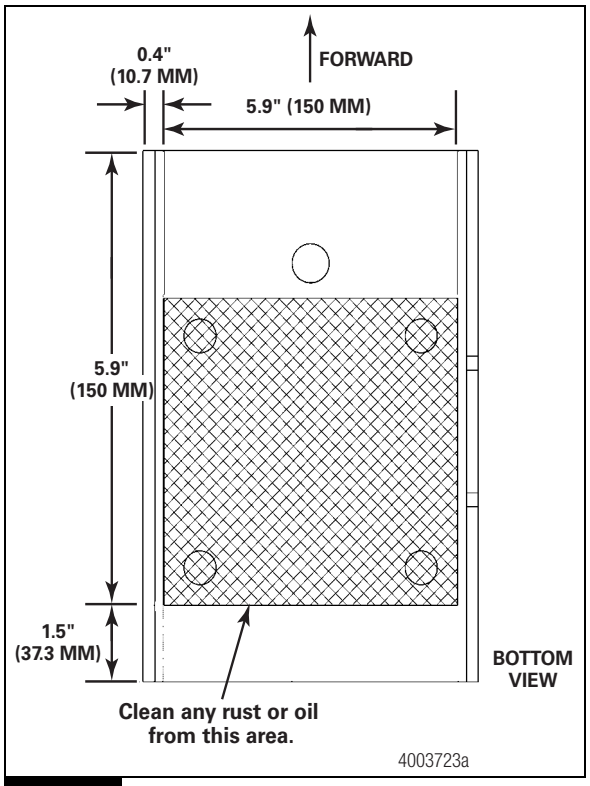


Figure 7.22

3. Verify that the pivot shaft mounting flanges on the idler arm and relay arm assemblies are clean.

4. Install the relay arm and idler arm assemblies to the subframe with eight new 5/8-11 x 2.0 capscrews, locknuts and hardened washers. Do not tighten the locknuts completely. Ensure that the locknut is threaded onto the capscrew at least 5/8-inch (15.88 mm). Leave enough room to install the relay rod. Figure 7.23.

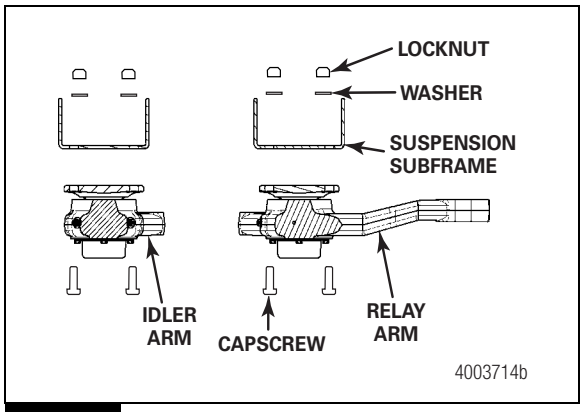


Figure 7.23

5. Position the relay rod into the idler arm and relay arm. Install the castle nuts that secure the relay rod to the idler arm and relay arm. Tighten the nuts to 245-260 lb-ft (332-353 N•m). Continue tightening the nuts to align the nut slot with the cotter pin hole. Do not back off the nuts to align the nut slot with the cotter pin hole. Install the cotter pins. Figure 7.24.

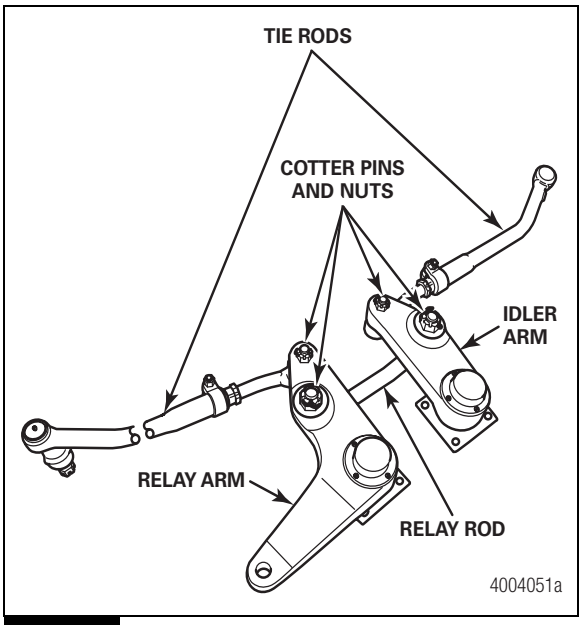


Figure 7.24

6. Tighten the idler arm and relay arm nuts to 180-210 lb-ft (245-286 N•m). Use a crossing pattern to tighten the nuts. Figure 7.25.

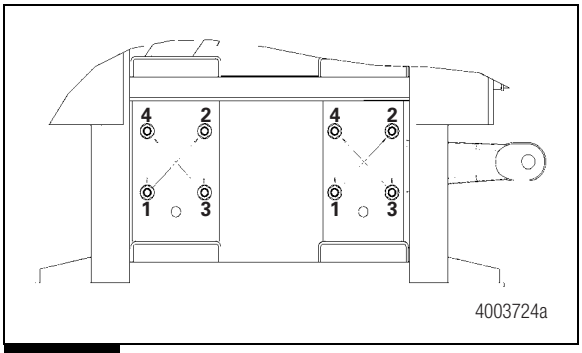


Figure 7.25

7. Position the tie rods into the idler arm and relay arm. Install the castle nuts and bolts that secure the tie rods to the idler arm and relay arm. Tighten the nuts to 245-260 lb-ft (332-353 N•m). Continue tightening the nuts to align the nut slot with the cotter pin hole. Do not back off the nuts to align the nut slot with the cotter pin hole. Install the cotter pins. Figure 7.24.

7 Assembly and Installation

8. Verify that the tie rods are the correct length and are within 1/8-inch (3 mm) of each other. The tie rod ends and the slotted adjustment sleeves must have the correct engagement with the tie rod. Adjust the tie rod length as necessary. Figure 7.26.

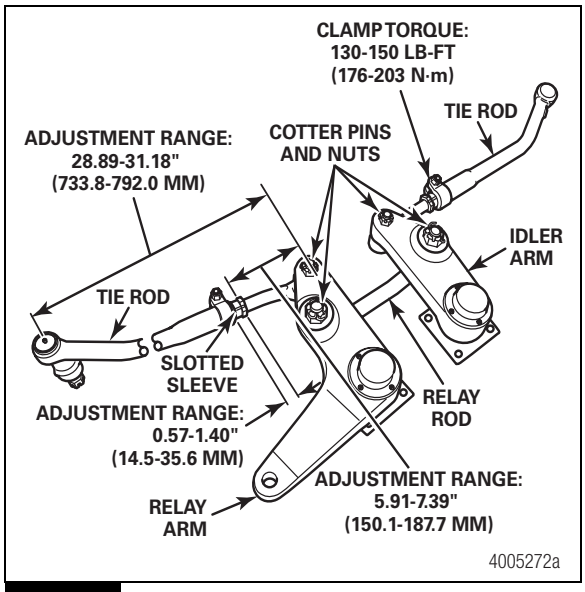


Figure 7.26

9. Position the tie rod into the steering arm. Install the nut that secures the tie rod to the steering arm. Tighten the nut to 245-260 lb-ft (332-353 N•m). Continue tightening the nut to align the nut slot with the cotter pin hole. Do not back off the nut to align the nut slot with the cotter pin hole. Install the cotter pin. Figure 7.27. ◆

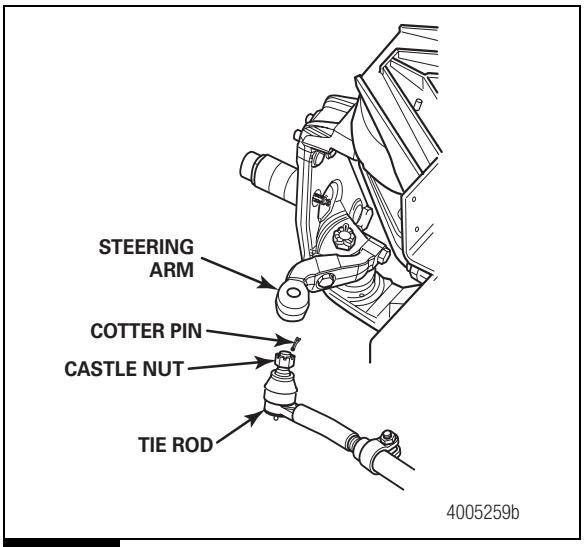


Figure 7.27

Hazard Alert Messages

Read and observe all Warning and Caution hazard alert messages in this publication. They provide information that can help prevent serious personal injury, damage to components, or both.

⚠ WARNING

To prevent serious eye injury, always wear safe eye protection when you perform vehicle maintenance or service.

Park the vehicle on a level surface. Block the wheels to prevent the vehicle from moving. Support the vehicle with safety stands. Do not work under a vehicle supported only by jacks. Jacks can slip and fall over. Serious personal injury and damage to components can result.

Release all air from the air suspension system before you raise the vehicle or remove any components. Pressurized air can cause serious personal injury.

Adjustment

Inspection Before Alignment

Before aligning the vehicle, perform a complete inspection and adjust the vehicle ride height.

Wheels and Tires

Verify that the wheels and tires meet the vehicle manufacturer's specifications. Verify that the tires are inflated to the pressure specified by the vehicle manufacturer.

Suspension

Inspect the suspension. Refer to Section 4.

Inspect the rear drive and tag axles, and suspension if equipped. Repair or replace any worn or damaged components. Refer to the suspension or vehicle manufacturer's instructions for the correct procedures.

Vehicle Ride Height Adjustment

The specified ride height is located on the suspension identification tag on the lower left-hand side of the subframe. Refer to the vehicle manufacturer's instructions to adjust the ride height.

Adjust the rear suspensions to the ride height specified by the suspension or vehicle manufacturer.

Maximum Turn Angle

⚠ CAUTION

Do not exceed the maximum turn angle specified by the suspension or vehicle manufacturer. If the angle is exceeded, the steering arms, tie rods and tie rod ends will be damaged.

The stop bolt on the back of the knuckle controls the maximum turn angle. If the stop bolt is missing, bent or broken, the system requires adjustment. Use the mechanical stop in the steering system to adjust the pressure relief.

Check the turn angle if the front tires rub against the frame or if the steering gear has been serviced. Use an alignment machine to check the angle. Refer to the alignment equipment manufacturer's procedures.

The stop bolt should NOT touch the lower control arm. The stop bolt should always have a minimum clearance of 1/8-inch (3 mm) when the knuckle is in the full-turn position as shown in Figure 8.1.

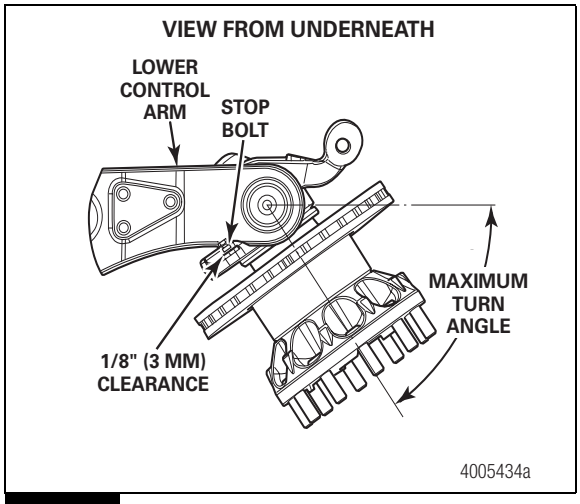


Figure 8.1

If the steering system is out-of-adjustment, inspect the steering arm for damage. Use a magnetic particle or liquid dye penetrant inspection procedure to inspect the steering arm. Pay particular attention to the bend, the taper and the area near the ball stud. Refer to the vehicle manufacturer's manual for additional inspection procedures.

8 Adjustment

Stop Bolt Adjustment

1. Place a 1/8-inch (3 mm) spacer between the stop bolt and the boss on the lower control arm.
2. Turn the steering wheel until the boss on the lower control arm touches the spacer in front of the stop bolt. Measure the turn angle. Figure 8.2.

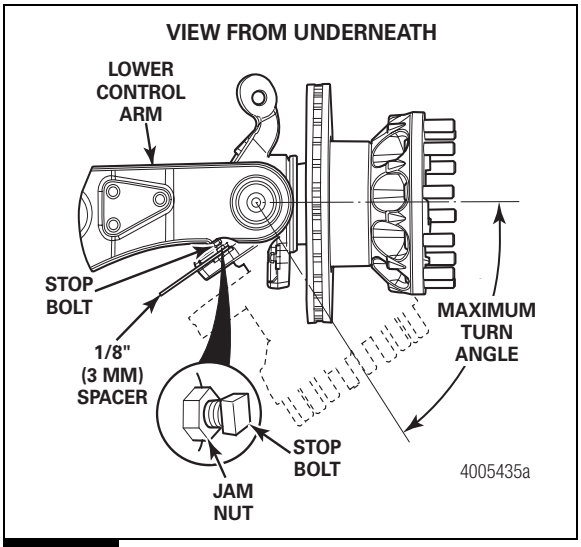


Figure 8.2

3. If the maximum turn angle does not meet the vehicle manufacturer's specifications, correct the maximum angle. Adjust the pressure relief.
4. When the maximum turn angle is correct:
   A. Loosen the stop bolt jam nut. Figure 8.2.
   B. Insert a 1/8-inch (3 mm) spacer and adjust the stop bolt.
   C. Tighten the jam nut to 103-111 lb-ft (140-150 N•m).

Adjust the Pressure Relief in the Power Steering System, Set the Maximum Turn Angle

⚠ CAUTION

In power steering systems, the hydraulic pressure should relieve or "drop off" at the end of the steering stroke, with 1/8-inch (3 mm) minimum clearance at the stop bolt. If the pressure does not relieve, the steering system components will be damaged.

The pressure relief in the power steering system stops or reduces forces applied to the axle when the wheel is moved in the full-turn position.

Check the pressure relief if the steering arm is damaged or the power steering gear is serviced.

Two types of systems are used to adjust the pressure relief.

- Mechanical stop on the Pitman arm or in the assist cylinder
- Hydraulic pressure relief in the power steering gear

⚠ CAUTION

Meritor does not recommend a power steering system that does not have mechanical stops or pressure relief before the maximum turn angle is obtained. Damage to the axle can result.

Mechanical Stop

Use the mechanical stop in the steering system to adjust the pressure relief. Do not use the stop bolt on the knuckle alone to adjust the poppet valve pressure relief.

Refer to the vehicle manufacturer's procedures.

⚠ CAUTION

Use a pressure gauge to verify that the pressure drops from the maximum system delivery pressure to gear box manufacturing recommendation BEFORE the full turning angle is achieved. If the pressure does not drop, damage to the front axle components will result.

Steering systems with mechanical stops are adjusted when the wheels are turned to the full-right and full-left turn positions. The stop travel is set at 1/8-inch (3 mm) before the stop bolt contacts the lower control arm boss. Figure 8.3 and Figure 8.4.

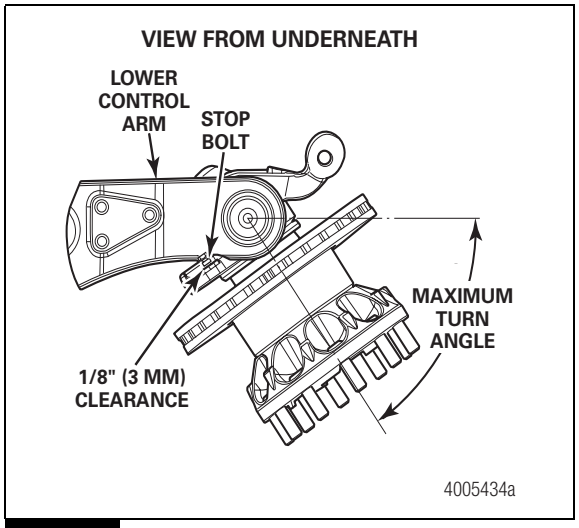


Figure 8.3

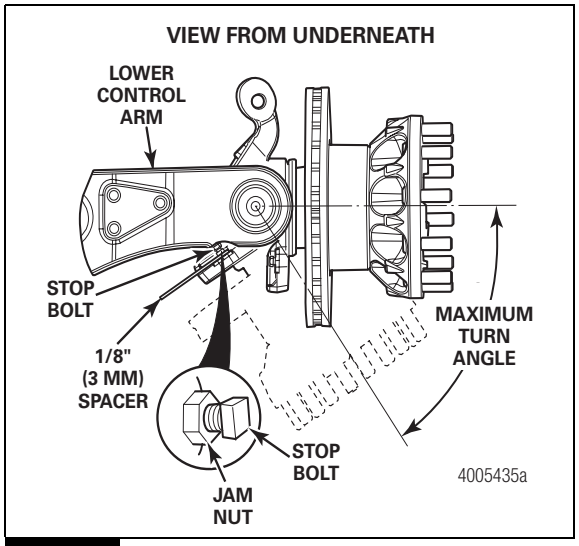


Figure 8.4

Hydraulic Pressure Relief in the Steering Gear

Refer to the vehicle manufacturer's procedure. The stop bolt should always have a minimum clearance of 1/8-inch (3 mm) between the stop bolt and the lower control arm boss.

Hydraulic steering gears with poppet valves are adjusted with a spacer between the stop bolt in the knuckle and the boss on the lower control arm. The poppet valves are adjusted to stop or reduce steering forces from the 1/8-inch (3 mm) specified distance between the lower control arm boss and the spacer. Figure 8.3 and Figure 8.4.

Turning Radius Angle

When turning, the inner wheel must turn at a greater angle than the outer wheel. This angle is the turning radius angle, often called the Ackerman angle. Figure 8.5.

Check the turning radius angle with the radius plates on the alignment equipment. To determine correct turning radius angle specification, refer to the vehicle manufacturer's manual.

- **If the angle is not within specifications:** Premature tire wear will occur. Inspect the knuckle, tie rod arms, tie rod ends and relay rod for wear or damage. Service as necessary.

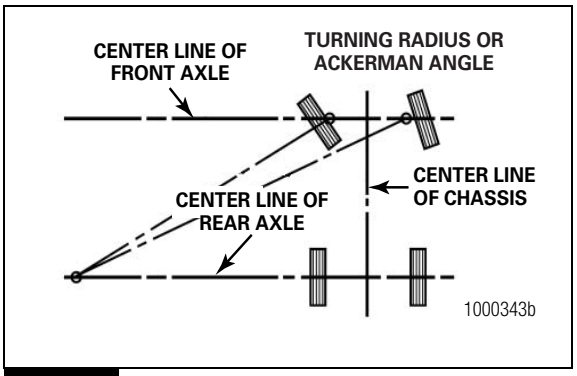


Figure 8.5

Measure and Adjust the Toe

Toe is the relationship of the distance between the front of the front tires and the rear of the front tires.

When the front distance is less than the rear distance, the wheels are "toed in." Toe-in is designed into the vehicle to counteract the tendency of the tires to toe-out when the vehicle is driven.

Incorrect toe will result in rapid tire wear.

1. Park the vehicle on a level surface. Block the wheels to prevent the vehicle from moving. Set the parking brake.

⚠ WARNING

Release all air from the air suspension system before you raise the vehicle or remove any components. Pressurized air can cause serious personal injury.

2. Use jacks to raise the vehicle so that the front tires are off the ground. Support the front axle with safety stands.
3. Use paint or chalk to mark the center area of both front tires around the complete outer surface of the tire.

8 Adjustment

4. Place the pointers of a trammel bar on the marks of each tire. Rotate the tires. Verify that a straight line is marked on the outer surface of the tire.
5. Place the trammel bar at the back of the tires. Raise the pointers so that the pointers are level with the spindles. Align the pointers with the marks on the tires. Measure and record the distance between the pointers.
6. Repeat Step 5 for the front of the tires. Figure 8.6.

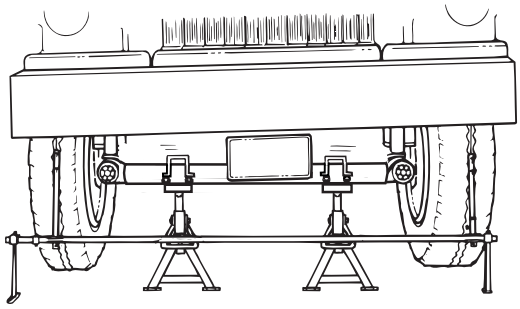


Figure 8.6

7. To obtain the toe measurement, subtract the distance reading between the front of the tires from the distance reading between the back of the tires. Figure 8.7.
   - **If the toe measurement is not 1/16-inch ± 1/16-inch (1.58 mm ± 1.58 mm) at 21.5-inches (546.1 mm) from the centerline of the suspension:** Use the following procedure to adjust the toe.
     A. Loosen the tube clamp nut and bolt on each end of the tie rod.
     B. Turn the adjusting sleeve until the specified toe distance is obtained.
     C. Verify that the tie rods are the correct length and within 1/8-inch (3 mm) of each other. The tie rod end and the adjusting sleeve must have the correct engagement with the tie rod. Figure 8.8.
     D. Tighten the tube clamp nut and bolt on each end of the cross tube to 130-150 lb-ft (176-203 N•m). Ensure that the tie rod is within the adjustment range. Figure 8.8.

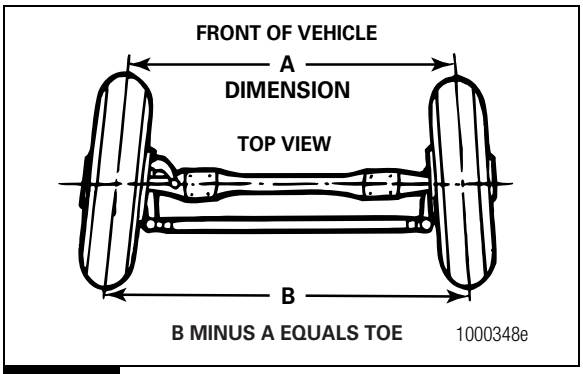


Figure 8.7

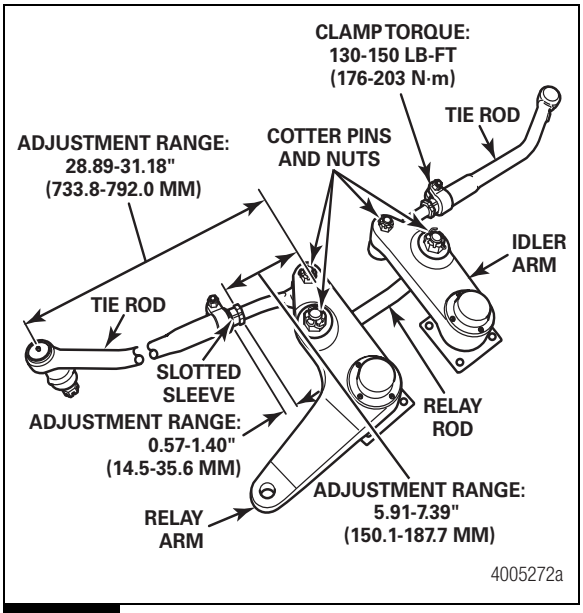


Figure 8.8

8. Repeat Steps 1-7 to check the toe dimension.

Table B: Tolerances and Limits

Description	Specification
Control Arm Ball Joint	65 mm ball joint: 0.059-inch (1.5 mm), 80 mm ball joint: 0.079-inch (2 mm) maximum axial free play
Hub Bearing End Play	0.001-0.005-inch (0.0254-0.127 mm)
Steering Relay Arm	No axial or radial free play allowed
Turn Angle	54 degrees maximum

Table C: Torque Values for Fasteners

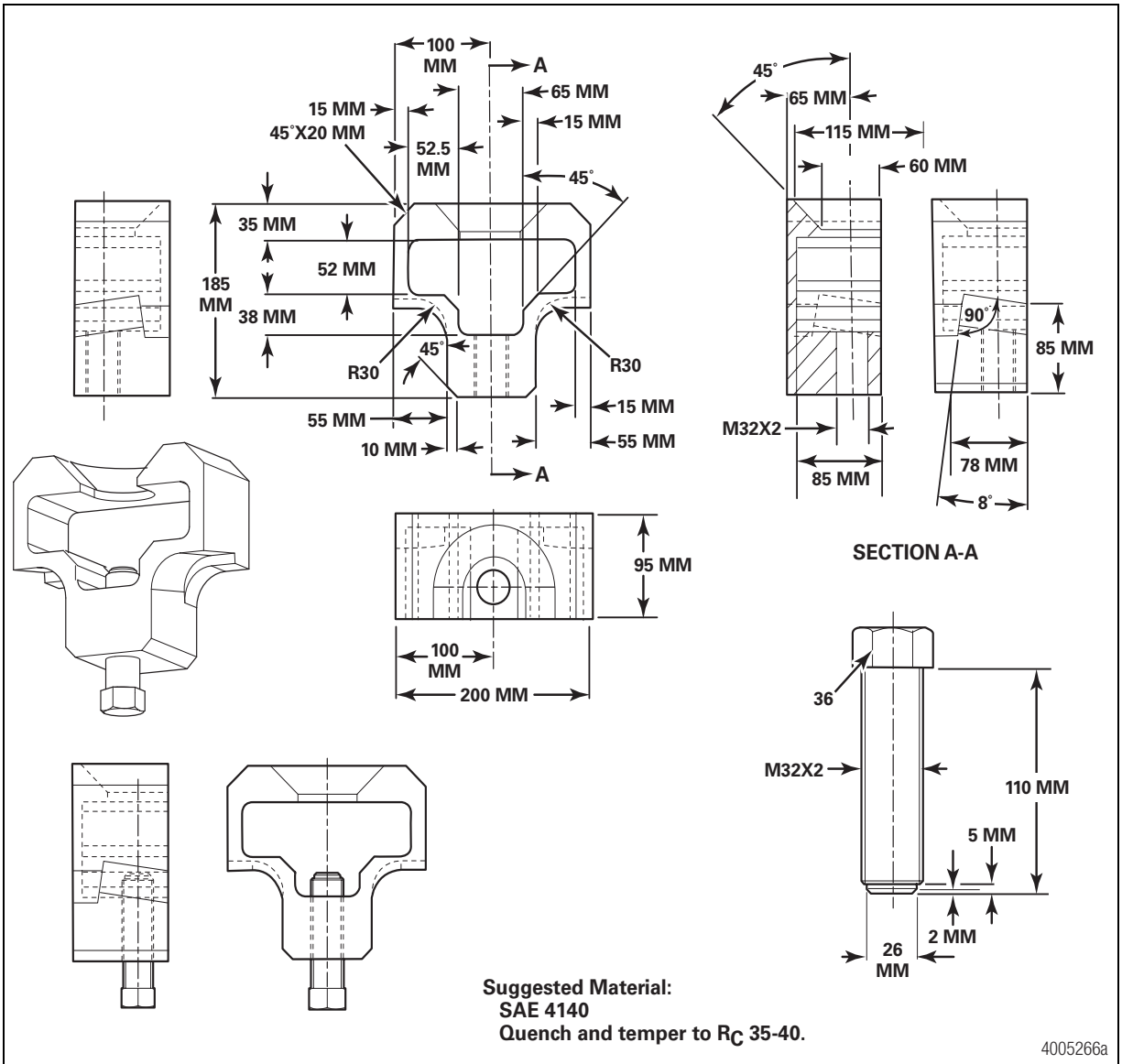
		Torque Range	
Description	Size	Lb-Ft	N•m
Air Spring-to-Control Arm Mounting Capscrews	M14 x 2 x 40	96-100	130-135
Air Spring-to-Subframe Nuts	M12 x 1.75	69-87	94-118
Air Spring Adapters	M16 x 1.5 to 3/8-18 NPTF	30-33	40-44
Air Spring Plugs	M16 x 1.5	41-44	55-60
Lower Ball Joint	80 mm	1033-1106	1400-1500
Upper Ball Joint	65 mm	1033-1106	1400-1500
Lower Control Arm Ball Joint Stud-to-Knuckle Retaining Nuts	—	922-959	1250-1300
Upper Control Arm Ball Joint Stud-to-Knuckle Retaining Nuts	—	553-590	750-800
Control Arm Bar Pin-to-Subframe Mounting Capscrews	M18 x 2.5 x 60	225-273	305-370
	M20 x 2.5 x 60	369-480	500-650
Spindle Nuts	—	406-420	550-570
Spindle Nut Socket Head Capscrew	M8 x 1.25 x 20	22-26	30-35
Wheel Adapter Capscrews	M18 x 1.25 x 80	321-332	435-450
Brake Mounting Socket Head Capscrews	M20 x 1.5	402-494	545-670
Brake Mounting Hex Head Capscrews	M20 x 1.5	402-494	545-670
Shock Absorber Bracket Retaining Socket Head Capscrews	M16 x 2 x 60	180-188	245-255
Shock Absorber Locknuts	3/4″-10	270-350	366-474
Steering Arm Mounting Capscrews	M20 x 1.5 x 70	406-428	550-580
Steering Relay Arm and Idler Arm Cover Capscrews	M6 x 1.0 x 12	8-9	10-12
Steering Assembly-to-Frame Nuts	5/8″-11	180-210	244-285
Tie Rod Clamp Nuts	—	130-150	176-203
Ball Stud-to-Steering Arm Stud Nuts	—	245-260	332-353
Steering Stop Locknuts	—	103-111	140-150
Leveling Valve Bracket Capscrew	M8 x 1.25	18-26	25-35

Table D: Lubricants

Item	Lubricant Specification
Tie Rod Ends, Relay Arm Bearing, Idler Arm Bearing	Meritor Specification O-617-A or equivalent, Multi-Purpose Chassis Grease, 6% 12-hydroxy lithium stearate grease, NLGI Grade 1, preferred Meritor Specification O-617-B or equivalent, Multi-Purpose Chassis Grease, 8% 1-hydroxy lithium stearate grease, NLGI Grade 2, acceptable

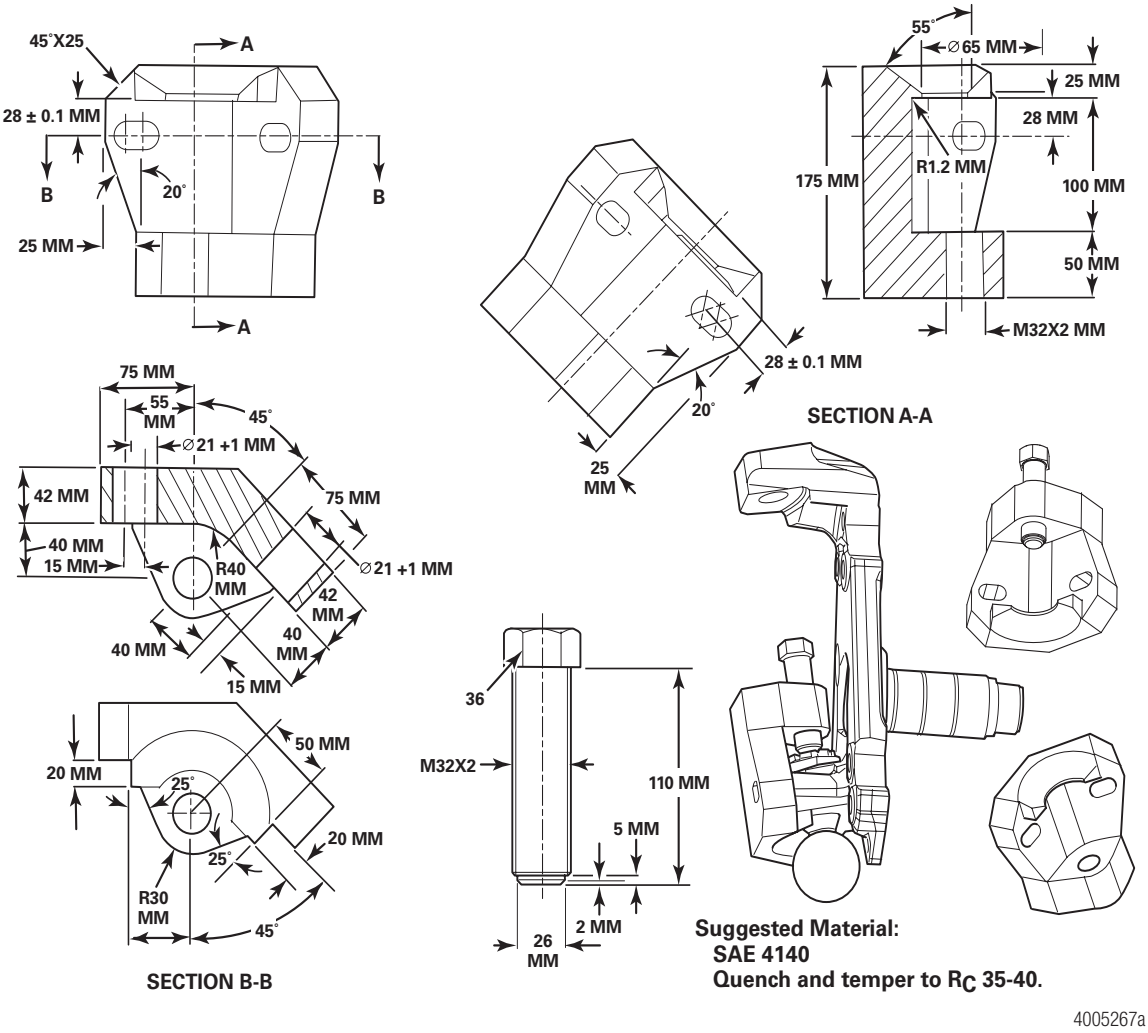
10 Special Tools

Tool Drawings



UPPER CONTROL ARM BALL JOINT REMOVAL TOOL

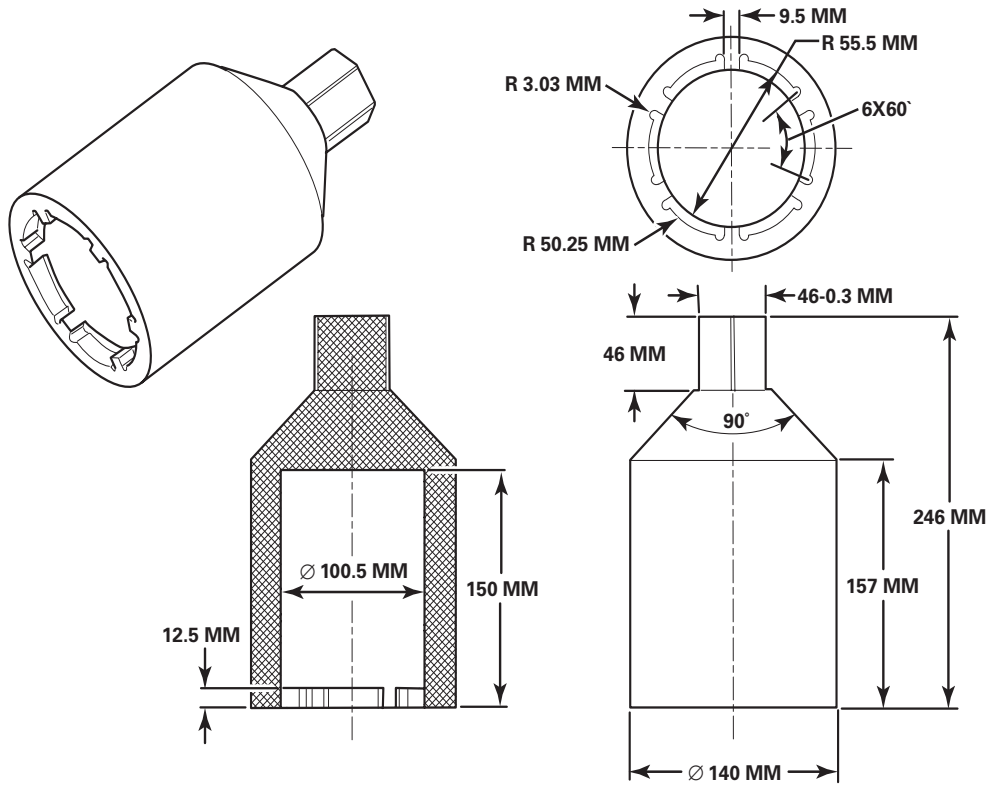
Figure 10.1



LOWER CONTROL ARM BALL JOINT REMOVAL TOOL

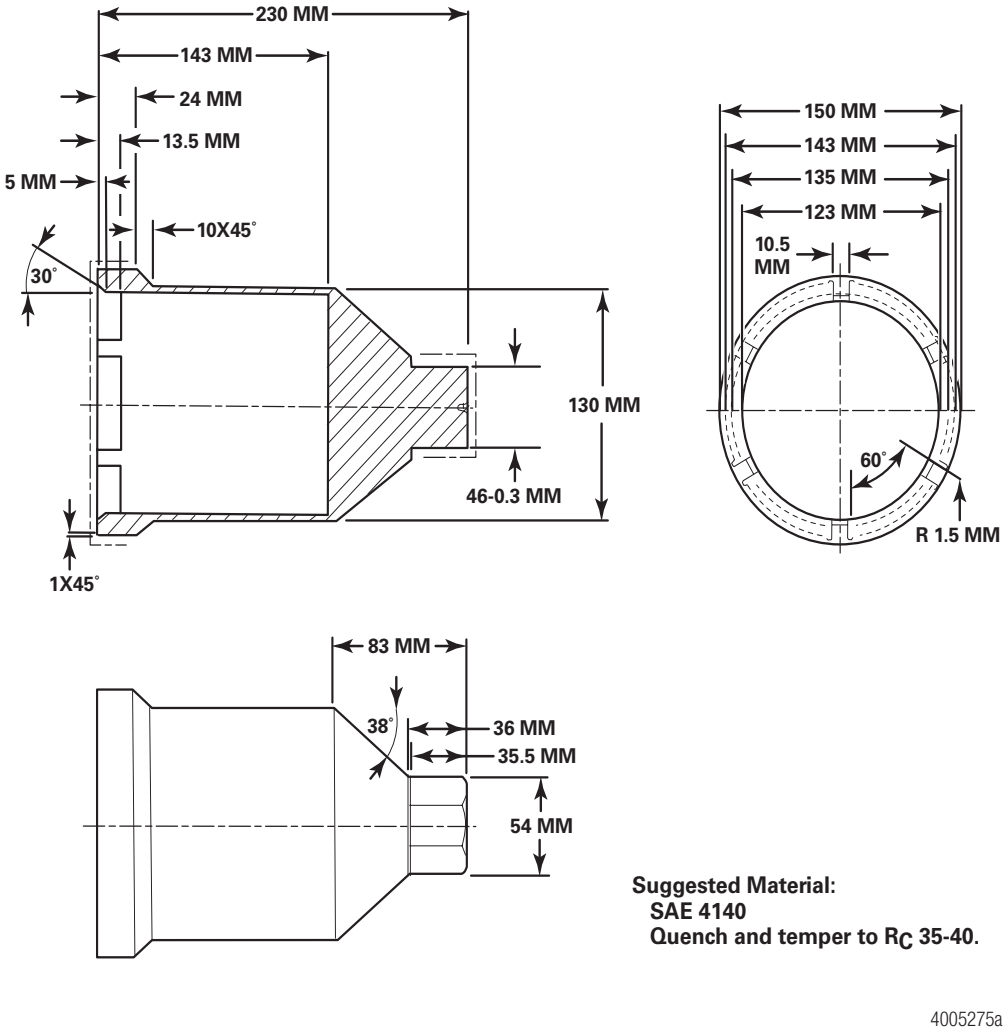
Figure 10.2

10 Special Tools



65 MM UPPER CONTROL ARM BALL JOINT REMOVAL AND INSTALLATION TOOL

Figure 10.3



80 MM LOWER CONTROL ARM BALL JOINT REMOVAL AND INSTALLATION TOOL

Figure 10.4

10 Special Tools

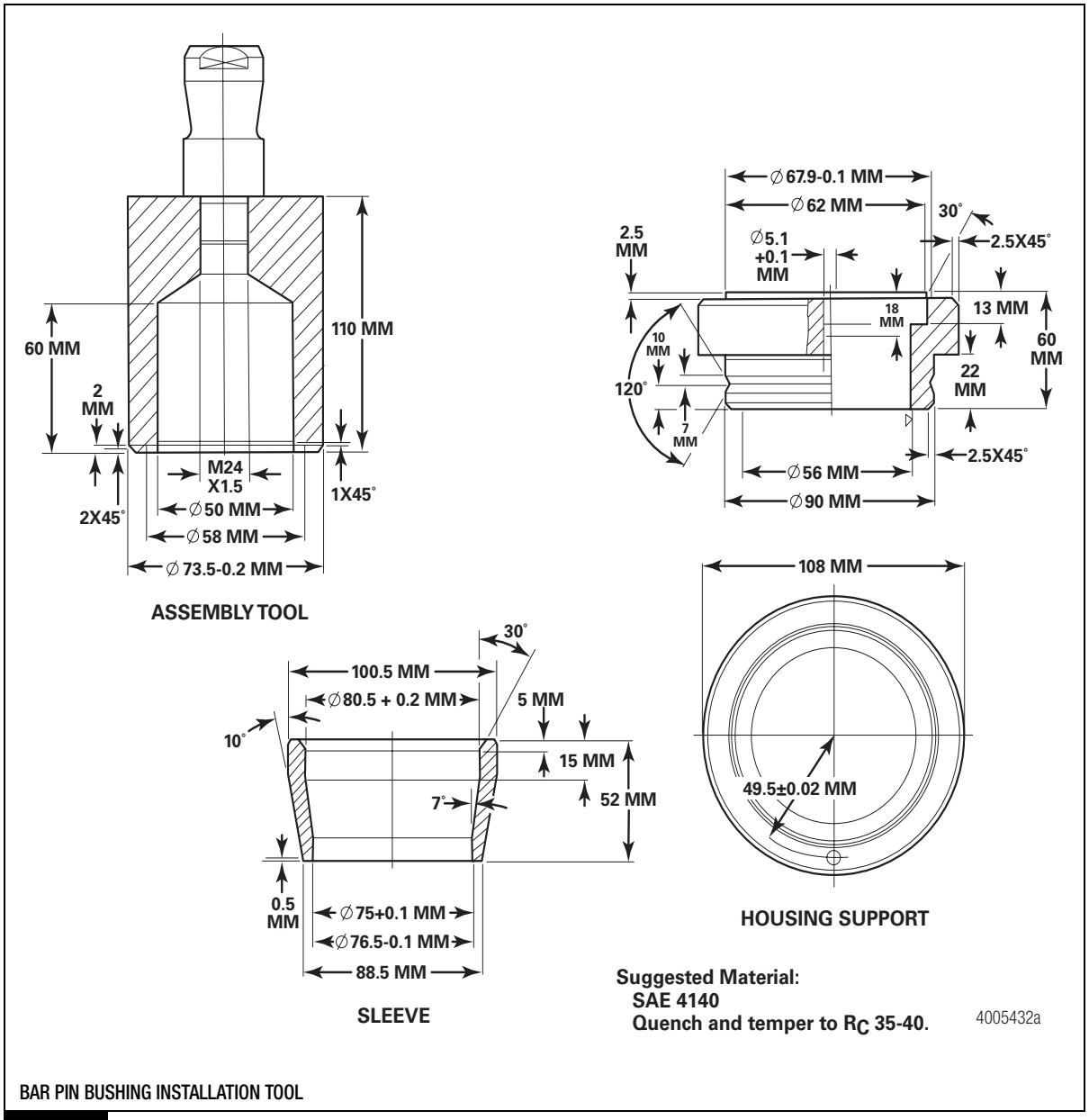


Figure 10.5

Spanner Socket

The spanner socket for the relay arm and idler arm assemblies is available from the following.

- SKF, part number HN 8-9
- Snap-on®, part number 58695C

Meritor Heavy Vehicle Systems, LLC
2135 West Maple Road
Troy, MI 48084 USA
800-535-5560
arvinmeritor.com

Printed in USA

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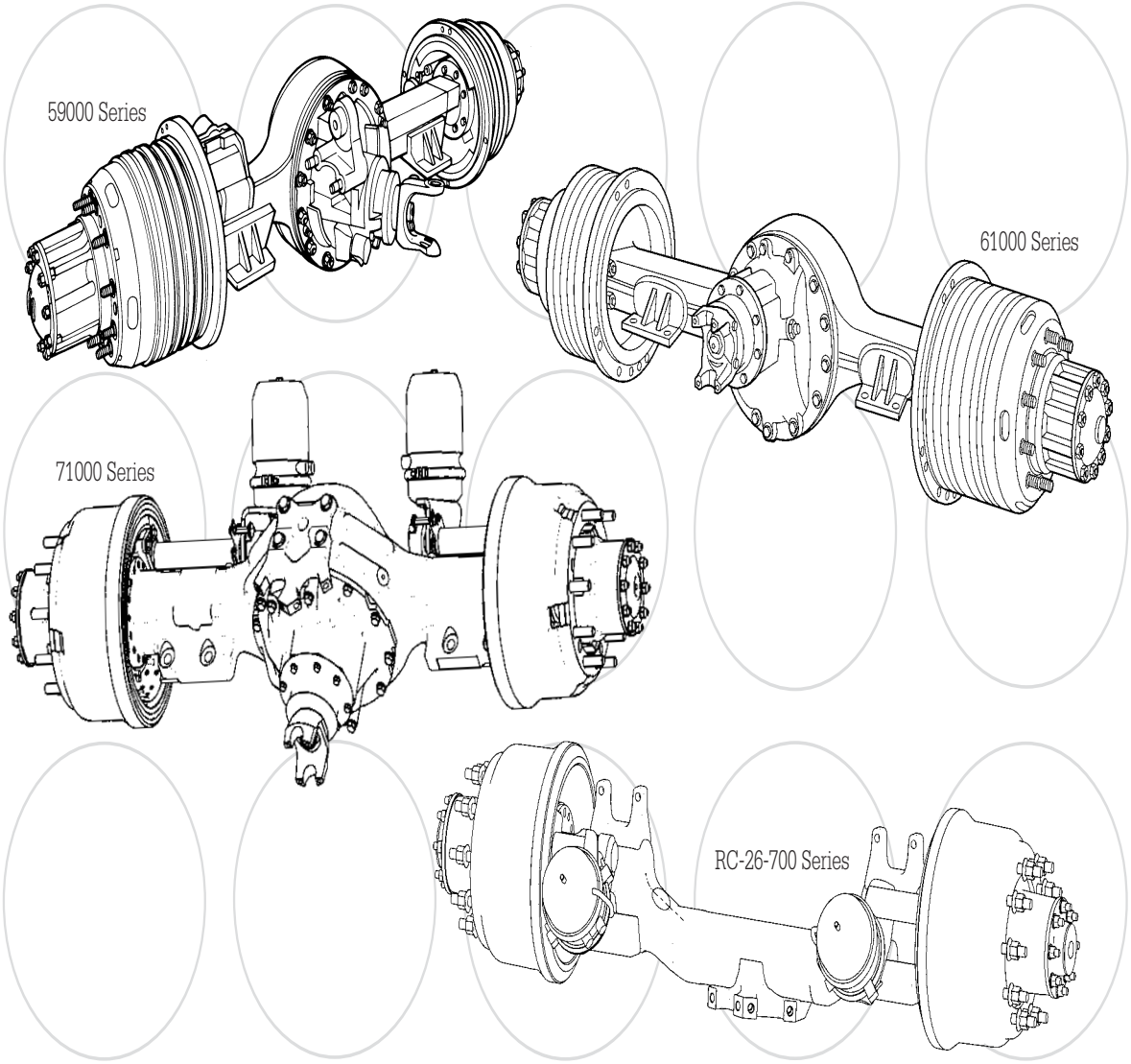
Maintenance Manual 23A

Bus and Coach Rear Axles

Revised 03-05



Service Notes

About This Manual

This manual provides maintenance and service information for the Meritor 59000, 61000, 71000, RC-23-160 and RC-26-700 Series bus and coach rear and center axles and T Series parking brake.

Before You Begin

1. Read and understand all instructions and procedures before you begin to service components.
2. Read and observe all Warning and Caution hazard alert messages in this publication. They provide information that can help prevent serious personal injury, damage to components, or both.
3. Follow your company's maintenance and service, installation, and diagnostics guidelines.
4. Use special tools when required to help avoid serious personal injury and damage to components.

Hazard Alert Messages and Torque Symbols

⚠ WARNING

A Warning alerts you to an instruction or procedure that you must follow exactly to avoid serious personal injury and damage to components.

⚠ CAUTION

A Caution alerts you to an instruction or procedure that you must follow exactly to avoid damage to components.

This symbol alerts you to tighten fasteners to a specified torque value.

How to Obtain Additional Maintenance and Service Information

On the Web

Visit the DriveTrain Plus™ by ArvinMeritor Tech Library at arvinmeritor.com to easily access product and service information. The Library also offers an interactive and printable Literature Order Form.

ArvinMeritor's Customer Service Center

Call ArvinMeritor's Customer Service Center at 800-535-5560.

Technical Electronic Library on CD

The DriveTrain Plus™ by ArvinMeritor Technical Electronic Library on CD contains product and service information for most Meritor and Meritor WABCO products. $20. Specify TP-9853.

How to Obtain Tools, Supplies and Brake Conversion Kits Specified in This Manual

Call ArvinMeritor's Commercial Vehicle Aftermarket at 888-725-9355 to obtain Meritor tools and supplies. Lined shoe kits and brake hardware kits are available. You also can obtain the following conversion kits.

- A kit to convert Q Series cam brake shoes (except models with cast shoes) to Q Series brakes with "quick change" shoes
- A kit to convert standard 16.5-inch Q Series cam brakes to Q Plus™ cam brakes

Contents

Contents

Asbestos and Non-Asbestos Fibers

⚠ ASBESTOS FIBERS WARNING

The following procedures for servicing brakes are recommended to reduce exposure to asbestos fiber dust, a cancer and lung disease hazard. Material Safety Data Sheets are available from ArvinMeritor.

Hazard Summary

Because some brake linings contain asbestos, workers who service brakes must understand the potential hazards of asbestos and precautions for reducing risks. Exposure to airborne asbestos dust can cause serious and possibly fatal diseases, including asbestosis (a chronic lung disease) and cancer, principally lung cancer and mesothelioma (a cancer of the lining of the chest or abdominal cavities). Some studies show that the risk of lung cancer among persons who smoke and who are exposed to asbestos is much greater than the risk for non-smokers. Symptoms of these diseases may not become apparent for 15, 20 or more years after the first exposure to asbestos.

Accordingly, workers must use caution to avoid creating and breathing dust when servicing brakes. Specific recommended work practices for reducing exposure to asbestos dust follow. Consult your employer for more details.

Recommended Work Practices

1. Separate Work Areas. Whenever feasible, service brakes in a separate area away from other operations to reduce risks to unprotected persons. OSHA has set a maximum allowable level of exposure for asbestos of 0.1 f/cc as an 8-hour time-weighted average and 1.0 f/cc averaged over a 30-minute period. Scientists disagree, however, to what extent adherence to the maximum allowable exposure levels will eliminate the risk of disease that can result from inhaling asbestos dust. OSHA requires that the following sign be posted at the entrance to areas where exposures exceed either of the maximum allowable levels:

DANGER: ASBESTOS
CANCER AND LUNG DISEASE HAZARD
AUTHORIZED PERSONNEL ONLY
RESPIRATORS AND PROTECTIVE CLOTHING
ARE REQUIRED IN THIS AREA.

2. Respiratory Protection. Wear a respirator equipped with a high-efficiency (HEPA) filter approved by NIOSH or MSHA for use with asbestos at all times when servicing brakes, beginning with the removal of the wheels.

3. Procedures for Servicing Brakes.

a. Enclose the brake assembly within a negative pressure enclosure. The enclosure should be equipped with a HEPA vacuum and worker arm sleeves. With the enclosure in place, use the HEPA vacuum to loosen and vacuum residue from the brake parts.

b. As an alternative procedure, use a catch basin with water and a biodegradable, non-phosphate, water-based detergent to wash the brake drum or rotor and other brake parts. The solution should be applied with low pressure to prevent dust from becoming airborne. Allow the solution to flow between the brake drum and the brake support or the brake rotor and caliper. The wheel hub and brake assembly components should be thoroughly wetted to suppress dust before the brake shoes or brake pads are removed. Wipe the brake parts clean with a cloth.

c. If an enclosed vacuum system or brake washing equipment is not available, employers may adopt their own written procedures for servicing brakes, provided that the exposure levels associated with the employer's procedures do not exceed the levels associated with the enclosed vacuum system or brake washing equipment. Consult OSHA regulations for more details.

d. Wear a respirator equipped with a HEPA filter approved by NIOSH or MSHA for use with asbestos when grinding or machining brake linings. In addition, do such work in an area with a local exhaust ventilation system equipped with a HEPA filter.

e. **NEVER** use compressed air by itself, dry brushing, or a vacuum not equipped with a HEPA filter when cleaning brake parts or assemblies. **NEVER** use carcinogenic solvents, flammable solvents, or solvents that can damage brake components as wetting agents.

4. Cleaning Work Areas. Clean work areas with a vacuum equipped with a HEPA filter or by wet wiping. **NEVER** use compressed air or dry sweeping to clean work areas. When you empty vacuum cleaners and handle used rags, wear a respirator equipped with a HEPA filter approved by NIOSH or MSHA for use with asbestos. When you replace a HEPA filter, wet the filter with a fine mist of water and dispose of the used filter with care.

5. Worker Clean-Up**.** After servicing brakes, wash your hands before you eat, drink or smoke. Shower after work. Do not wear work clothes home. Use a vacuum equipped with a HEPA filter to vacuum work clothes after they are worn. Launder them separately. Do not shake or use compressed air to remove dust from work clothes.

6. Waste Disposal. Dispose of discarded linings, used rags, cloths and HEPA filters with care, such as in sealed plastic bags. Consult applicable EPA, state and local regulations on waste disposal.

Regulatory Guidance

References to OSHA, NIOSH, MSHA, and EPA, which are regulatory agencies in the United States, are made to provide further guidance to employers and workers employed within the United States. Employers and workers employed outside of the United States should consult the regulations that apply to them for further guidance.

⚠ NON-ASBESTOS FIBERS WARNING

The following procedures for servicing brakes are recommended to reduce exposure to non-asbestos fiber dust, a cancer and lung disease hazard. Material Safety Data Sheets are available from ArvinMeritor.

Hazard Summary

Most recently manufactured brake linings do not contain asbestos fibers. These brake linings may contain one or more of a variety of ingredients, including glass fibers, mineral wool, aramid fibers, ceramic fibers and silica that can present health risks if inhaled. Scientists disagree on the extent of the risks from exposure to these substances. Nonetheless, exposure to silica dust can cause silicosis, a non-cancerous lung disease. Silicosis gradually reduces lung capacity and efficiency and can result in serious breathing difficulty. Some scientists believe other types of non-asbestos fibers, when inhaled, can cause similar diseases of the lung. In addition, silica dust and ceramic fiber dust are known to the State of California to cause lung cancer. U.S. and international agencies have also determined that dust from mineral wool, ceramic fibers and silica are potential causes of cancer.

Accordingly, workers must use caution to avoid creating and breathing dust when servicing brakes. Specific recommended work practices for reducing exposure to non-asbestos dust follow. Consult your employer for more details.

Recommended Work Practices

1. Separate Work Areas. Whenever feasible, service brakes in a separate area away from other operations to reduce risks to unprotected persons.

2. Respiratory Protection. OSHA has set a maximum allowable level of exposure for silica of 0.1 mg/m^3 as an 8-hour time-weighted average. Some manufacturers of non-asbestos brake linings recommend that exposures to other ingredients found in non-asbestos brake linings be kept below 1.0 f/cc as an 8-hour time-weighted average. Scientists disagree, however, to what extent adherence to these maximum allowable exposure levels will eliminate the risk of disease that can result from inhaling non-asbestos dust.

Therefore, wear respiratory protection at all times during brake servicing, beginning with the removal of the wheels. Wear a respirator equipped with a high-efficiency (HEPA) filter approved by NIOSH or MSHA, if the exposure levels may exceed OSHA or manufacturers' recommended maximum levels. Even when exposures are expected to be within the maximum allowable levels, wearing such a respirator at all times during brake servicing will help minimize exposure.

3. Procedures for Servicing Brakes.

a. Enclose the brake assembly within a negative pressure enclosure. The enclosure should be equipped with a HEPA vacuum and worker arm sleeves. With the enclosure in place, use the HEPA vacuum to loosen and vacuum residue from the brake parts.

b. As an alternative procedure, use a catch basin with water and a biodegradable, non-phosphate, water-based detergent to wash the brake drum or rotor and other brake parts. The solution should be applied with low pressure to prevent dust from becoming airborne. Allow the solution to flow between the brake drum and the brake support or the brake rotor and caliper. The wheel hub and brake assembly components should be thoroughly wetted to suppress dust before the brake shoes or brake pads are removed. Wipe the brake parts clean with a cloth.

c. If an enclosed vacuum system or brake washing equipment is not available, carefully clean the brake parts in the open air. Wet the parts with a solution applied with a pump-spray bottle that creates a fine mist. Use a solution containing water, and, if available, a biodegradable, non-phosphate, water-based detergent. The wheel hub and brake assembly components should be thoroughly wetted to suppress dust before the brake shoes or brake pads are removed. Wipe the brake parts clean with a cloth.

d. Wear a respirator equipped with a HEPA filter approved by NIOSH or MSHA when grinding or machining brake linings. In addition, do such work in an area with a local exhaust ventilation system equipped with a HEPA filter.

e. **NEVER** use compressed air by itself, dry brushing, or a vacuum not equipped with a HEPA filter when cleaning brake parts or assemblies. **NEVER** use carcinogenic solvents, flammable solvents, or solvents that can damage brake components as wetting agents.

4. Cleaning Work Areas. Clean work areas with a vacuum equipped with a HEPA filter or by wet wiping. **NEVER** use compressed air or dry sweeping to clean work areas. When you empty vacuum cleaners and handle used rags, wear a respirator equipped with a HEPA filter approved by NIOSH or MSHA, to minimize exposure. When you replace a HEPA filter, wet the filter with a fine mist of water and dispose of the used filter with care.

5. Worker Clean-Up. After servicing brakes, wash your hands before you eat, drink or smoke. Shower after work. Do not wear work clothes home. Use a vacuum equipped with a HEPA filter to vacuum work clothes after they are worn. Launder them separately. Do not shake or use compressed air to remove dust from work clothes.

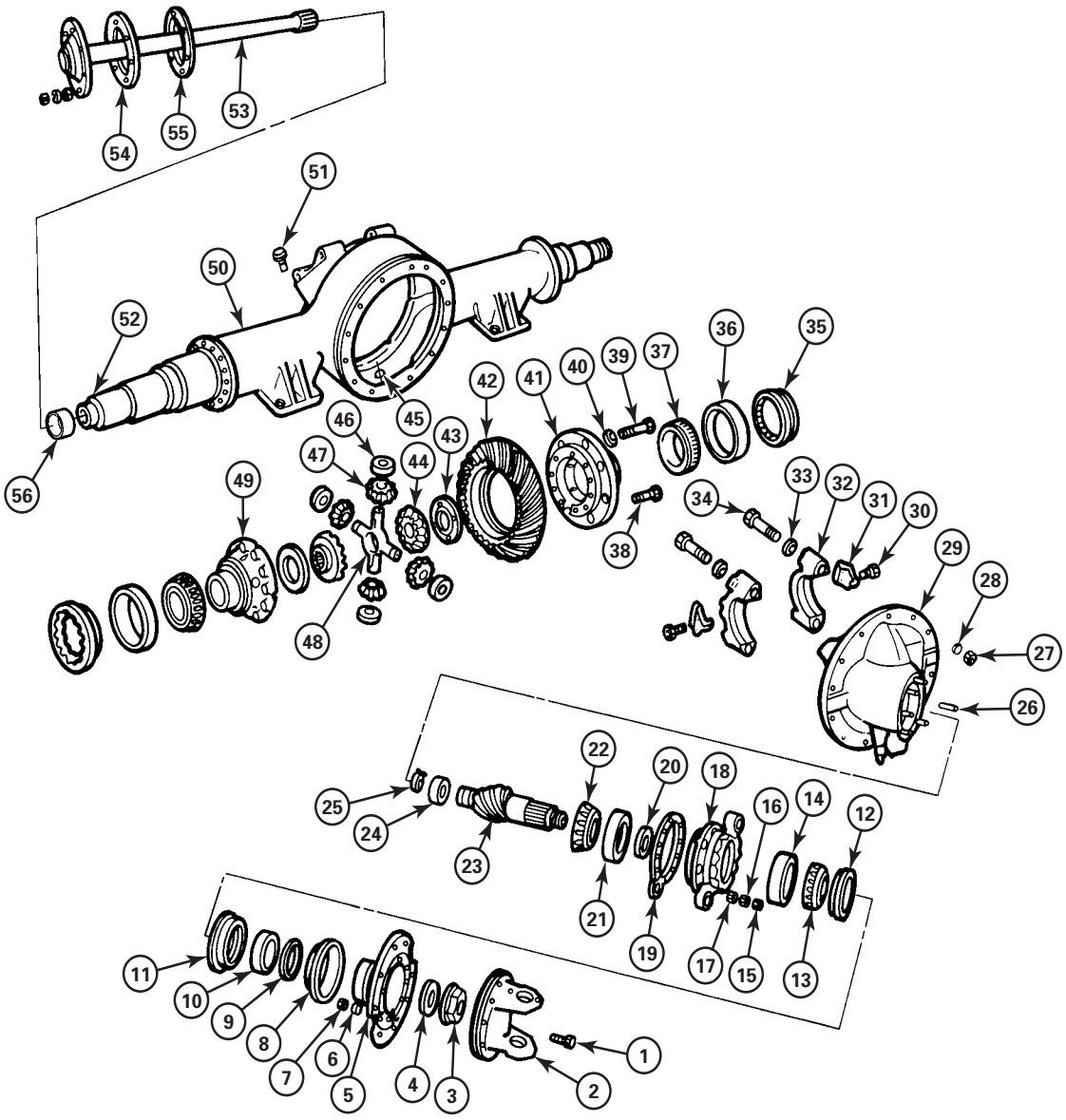
6. Waste Disposal**.** Dispose of discarded linings, used rags, cloths and HEPA filters with care, such as in sealed plastic bags. Consult applicable EPA, state and local regulations on waste disposal.

Regulatory Guidance

References to OSHA, NIOSH, MSHA, and EPA, which are regulatory agencies in the United States, are made to provide further guidance to employers and workers employed within the United States. Employers and workers employed outside of the United States should consult the regulations that apply to them for further guidance.

1 Exploded Views

59000 Series Rear Axle



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1 Exploded Views

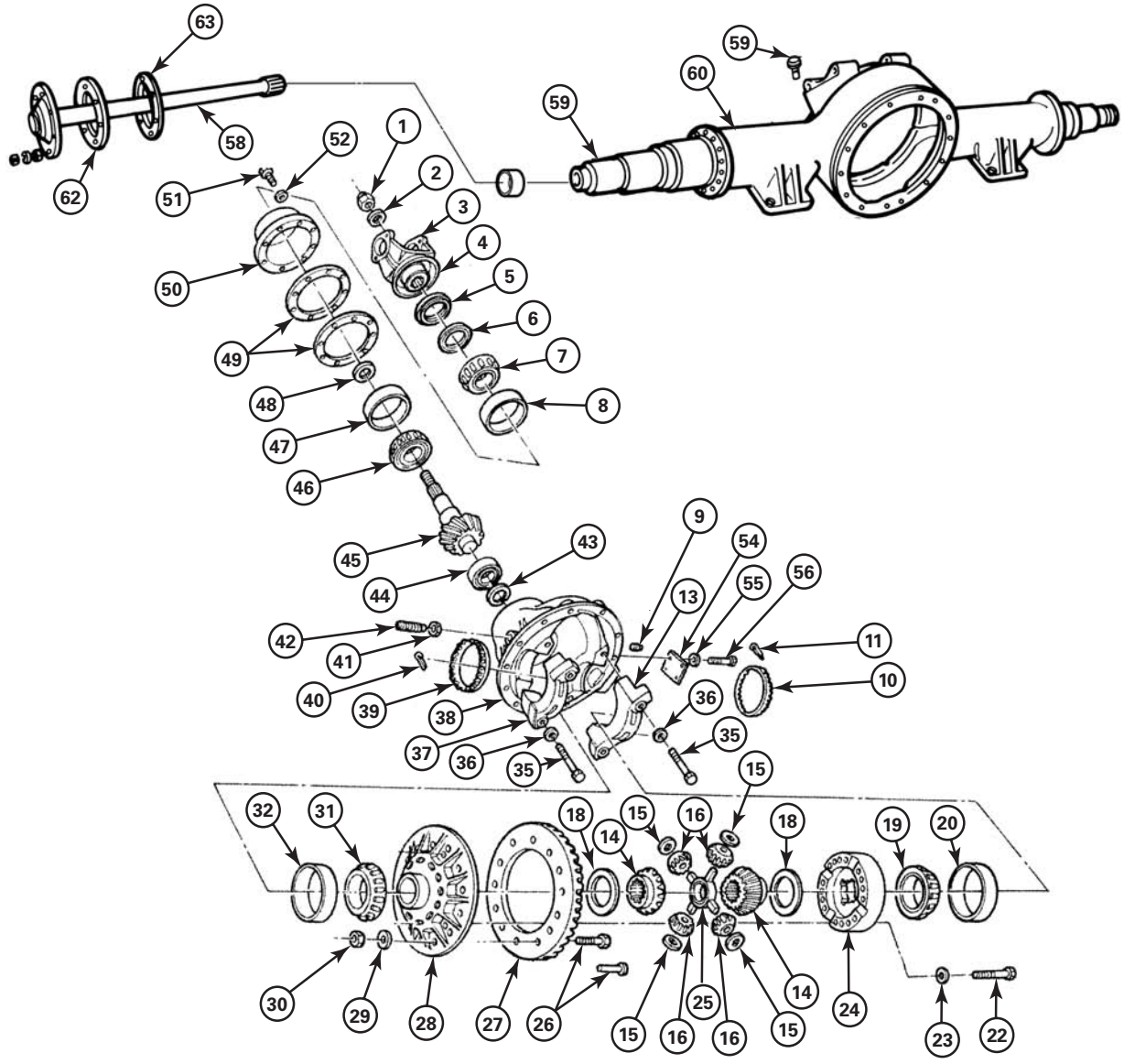
Item	Description
1	Bolt
2	Propeller Shaft Yoke Flange
3	Pinion Nut
4	Washer
5	Differential Companion Flange
6	Washer
7	Flange Nut
8	Dust Wiper
9	Oil Seal
10	Oil Seal Wiper
11	Oil Deflector
12	Oil Seal Retainer
13	Outer Bearing Cone
14	Outer Bearing Cup
15	Nut
16	Washer
17	Dowel
18	Pinion Cage, Spider
19	Shim*
20	Spacer*
21	Inner Bearing Cup
22	Inner Bearing Cone
23	Drive Pinion
24	Rear Bearing
25	Lock Ring
26	Spider Stud
27	Nut
28	Washer
29	Differential Carrier
30	Lock Bolt
31	Adjusting Ring Lock
32	Bearing Cap
33	Washer
34	Differential Bearing Capscrew
35	Adjusting Ring

Item	Description
36	Differential Bearing Cup
37	Differential Bearing Cone
38	Drive Gear Capscrew
39	Differential Case Capscrew
40	Washer
41	Differential Left-Half Case
42	Drive Gear
43	Side Gear Thrust Washer
44	Side Gear
45	Magnetic Drain Plug
46	Pinion Thrust Washer
47	Differential Side Pinion
48	Spider
49	Differential Right-Half Case
50	Axle Housing
51	Breather
52	Load Tube
53	Axle Shaft
54	Gasket
55	Grease Seal, Optional
56	Grease Seal Sleeve, Optional

* Thickness as required

1 Exploded Views

61000 Series Rear Axle



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1 Exploded Views

Item	Description
1	Drive Pinion Nut
2	Drive Pinion Washer
3	Input Yoke or Flange
4	Deflector
5	POSE™ Seal
6	Triple Lip or Main Seal
7	Outer Bearing Cone
8	Inner Bearing Cup
9	Plug[1]
10	Right-Half Adjusting Ring
11	Adjusting Ring Cotter Pin
12	Not Applicable
13	Not Applicable
14	Differential Side Gears
15	Differential Pinion Thrust Washers
16	Differential Pinions
18	Differential Side Gear Thrust Washers
19	Differential Right-Half Bearing Cone
20	Differential Right-Half Bearing Cup
22	Differential Case Capscrew
23	Differential Case Washers
24	Main Differential Case, Plain Half
25	Differential Spider
26	Ring Gear-to-Case Half Bolts or Rivets [2]
27	Ring Gear, Pinion Drive Gear
28	Main Differential Case, Flange Half
29	Ring Gear Bolt Washer
30	Ring Gear Bolt Nut
31	Differential Left-Half Bearing Cone
32	Differential Left-Half Bearing Cup
35	Differential Bearing Cap Capscrews
36	Washers
37	Differential Left-Half Bearing Cap
38	Carrier
39	Adjusting Ring
40	Adjusting Ring Cotter Pin

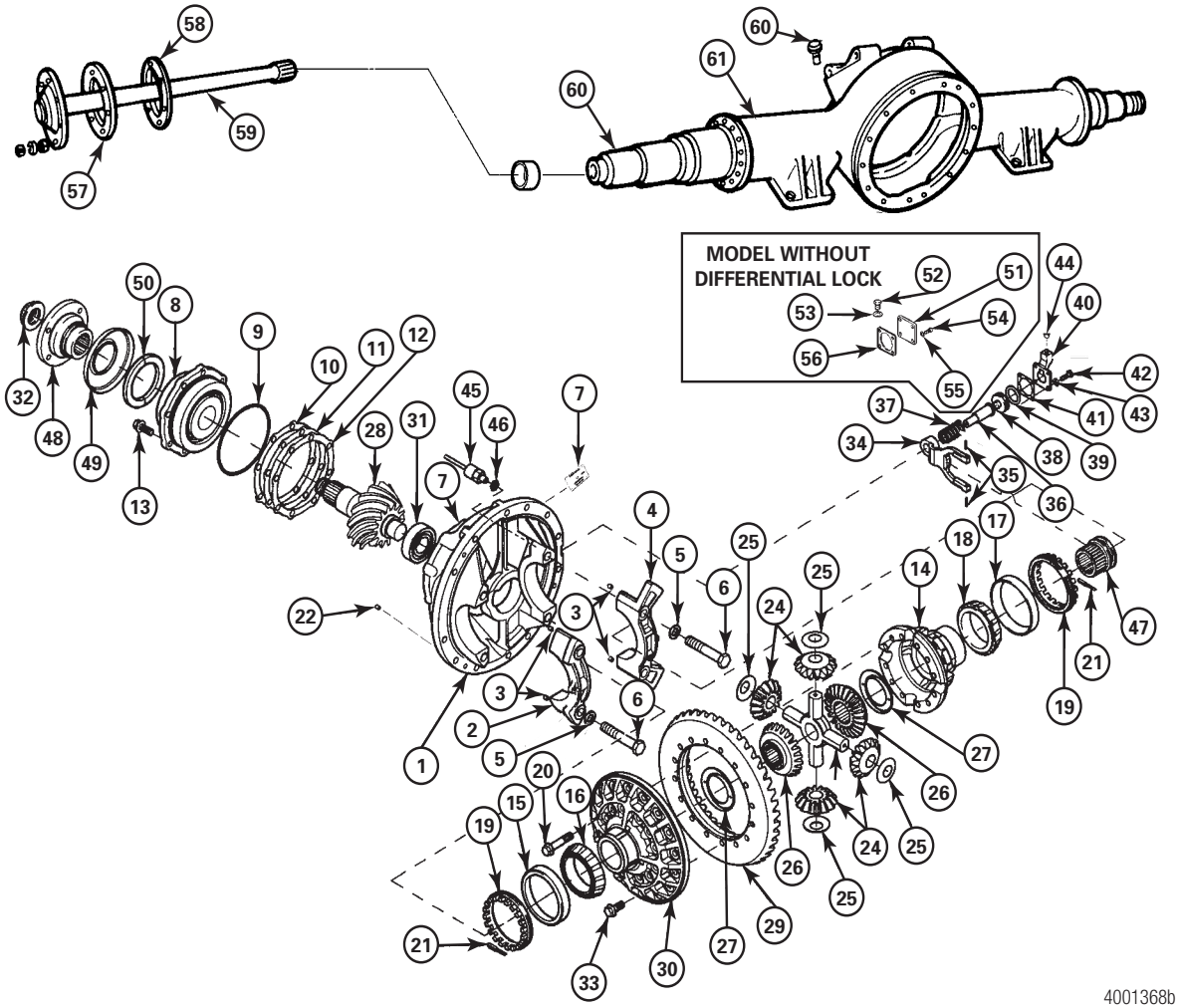
Item	Description
41	Thrust Screw Jam Nut [1]
42	Thrust Screw [1]
43	Snap Ring
44	Spigot Bearing
45	Drive Pinion
46	Pinion Inner Bearing Cone
47	Pinion Inner Bearing Cup
48	Pinion Bearing Spacer [2]
49	Shims [2]
50	Drive Pinion Bearing Cage
51	Bearing Cage Capscrew
52	Washer
54	Bolt-On Cover [1]
55	Washer [1]
56	Bolt [1]
58	Axle Shaft
59	Load Tube
60	Axle Housing
61	Breather
62	Gasket
63	Grease Seal, Optional
64	Grease Seal Sleeve, Optional

[1] Not available on all designs

[2] Thickness as required

1 Exploded Views

71000 Series Rear Axle



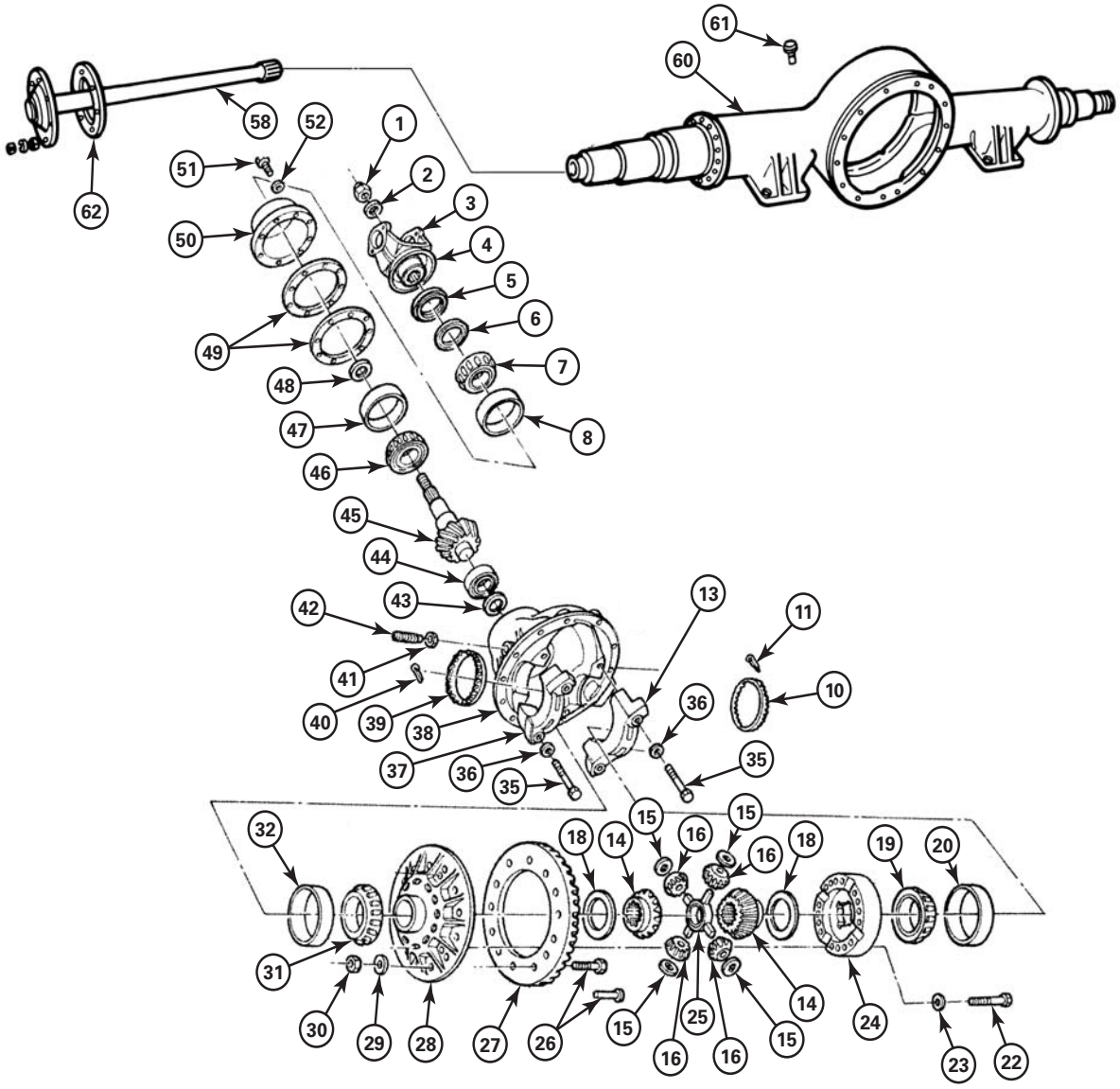
1 Exploded Views

Item	Description
1	Carrier
2	Left-Half Bearing Cap
3	Pin
4	Right-Half Bearing Cap
5	Bearing Cap Washer
6	Bearing Cap Capscrew
7	Identification Plate
8	Pinion Bearing Cage
9	O-Ring, Pinion Cage
10	Pinion Cage Shim
11	Pinion Cage Shim
12	Pinion Cage Shim
13	Pinion Cage Capscrew
14	Plain Half Differential Case
15	Differential Left-Half Bearing Cup
16	Differential Left-Half Bearing Cone
17	Differential Right-Half Bearing Cup
18	Differential Right-Half Bearing Cone
19	Adjusting Ring
20	Differential Case Screw
21	Cotter Pin
22	Plug
23	Differential Spider
24	Differential Pinion
25	Differential Pinion Thrust Washer
26	Differential Side Gear
27	Side Gear Thrust Washer
28	Drive Pinion
29	Drive Gear
30	Flange Half Differential Case
31	Pinion Spigot Bearing
32	Drive Pinion Nut
33	Drive Gear Screw
34	Shift Fork
35	Shift Fork Pin

Item	Description
36	Shift Shaft
37	Shift Shaft Spring
38	Piston
39	Piston O-Ring
40	Cylinder End Cover
41	Cylinder Cover Gasket
42	Cover Capscrew
43	Cover Capscrew Washer
44	Plug
45	Sensor Switch
46	Locknut Sensor Switch
47	Clutch Collar
48	Companion Flange
49	Deflector
50	Pinion-Pac Seal
	Model Without Differential Lock
51	End Cover
52	Sensor Switch Hole Blanking Plug
53	Washer Plug
54	End Cover Capscrew
55	End Cover Capscrew Washer
56	End Cover Gasket
57	Gasket
58	Grease Seal, Optional
59	Axle Shaft
60	Load Tube
61	Axle Housing

1 Exploded Views

RC-23-160 Series Rear Axle



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1 Exploded Views

Item	Description
1	Drive Pinion Nut
2	Drive Pinion Washer
3	Input Yoke or Flange
4	Deflector
5	POSE™ Seal
6	Triple Lip or Main Seal
7	Outer Bearing Cone
8	Inner Bearing Cup
9	Not Applicable
10	Right-Half Adjusting Ring
11	Adjusting Ring Cotter Pin
12	Not Applicable
13	Not Applicable
14	Differential Side Gears
15	Differential Pinion Thrust Washers
16	Differential Pinions
18	Differential Side Gear Thrust Washers
19	Differential Right-Half Bearing Cone
20	Differential Right-Half Bearing Cup
22	Differential Case Capscrew
23	Differential Case Washers
24	Main Differential Case, Plain Half
25	Differential Spider
26	Bolts or Rivets — Ring Gear-to-Case Half [1]
27	Ring Gear, Pinion Drive Gear
28	Main Differential Case, Flange Half
29	Ring Gear Bolt Washer
30	Ring Gear Bolt Nut
31	Differential Left-Half Bearing Cone
32	Differential Left-Half Bearing Cup
35	Differential Bearing Cap Capscrews
36	Washers
37	Differential Left-Half Bearing Cap
38	Carrier

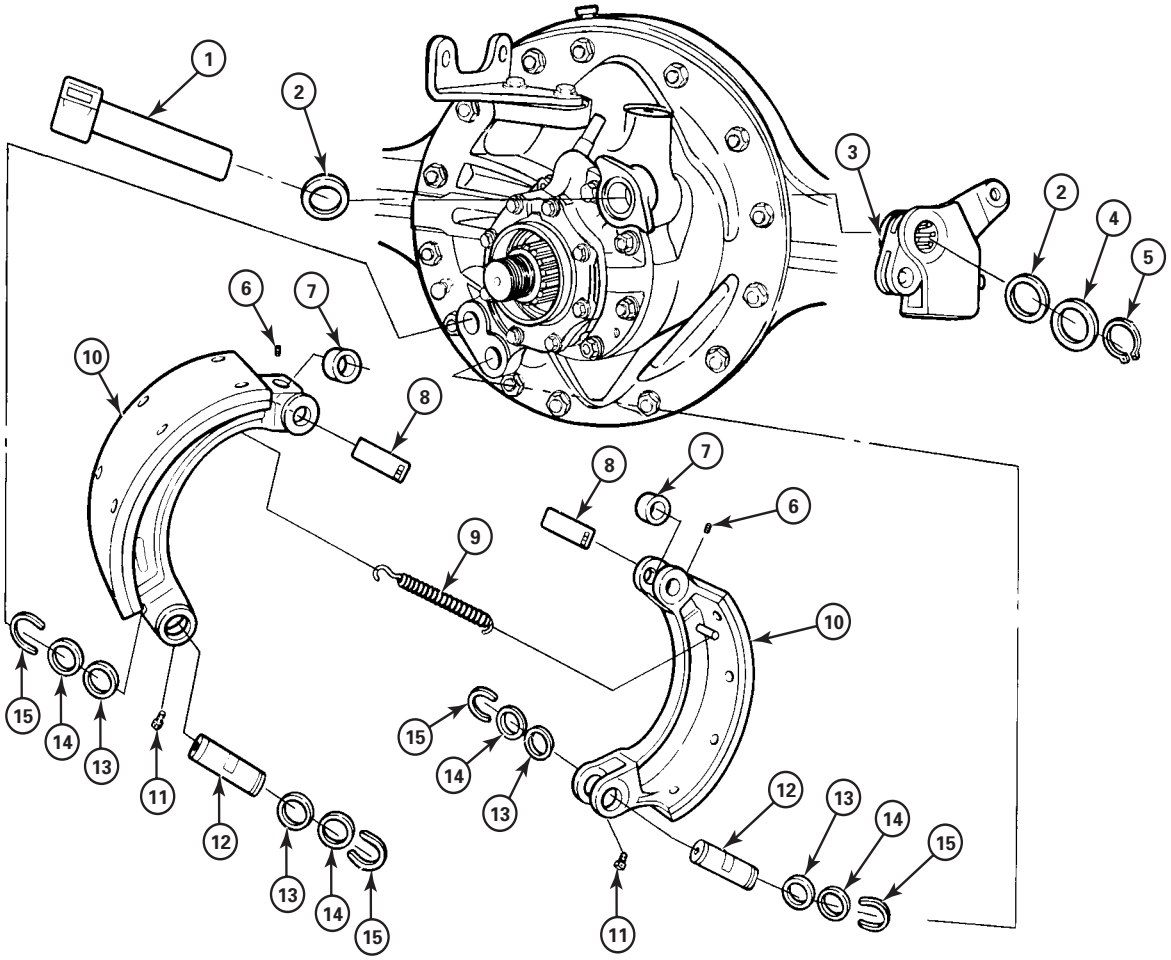
Item	Description
39	Adjusting Ring
40	Adjusting Ring Cotter Pin
41	Thrust Screw Jam Nut [2]
42	Thrust Screw [2]
43	Snap Ring
44	Spigot Bearing
45	Drive Pinion
46	Pinion Inner Bearing Cone
47	Pinion Inner Bearing Cup
48	Pinion Bearing Spacer [1]
49	Shims [1]
50	Drive Pinion Bearing Cage
51	Bearing Cage Capscrew
52	Washer
53	Not Applicable
54	Not Applicable
55	Not Applicable
56	Not Applicable
58	Axle Shaft
59	Not Applicable
60	Axle Housing
61	Breather
62	Gasket

[1] Thickness as required

[2] Not available on all designs

1 Exploded Views

T Series Parking Brake — 59000 Series Rear Axle



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Item	Description
1	Camshaft
2	Washer
3	Adjuster Assembly
4	Washer
5	Snap Ring
6	Set Screw
7	Cam Roller
8	Shaft
9	Spring

Item	Description
10	Brake Shoe Assembly
11	Lock Screw
12	Anchor Pin
13	Oil Seal
14	Oil Seal Retainer
15	Anchor Pin Lock

Models Covered

59722	59843	61143	71163
59723	61042	61152	RC-23-160
59732	61043	61153	RC-26-700
59733	61052	61162	T Series Parking Brake
59752	61053	61163	
59753	61063	71063	
59842	61142	71162	

Description

Rear Axles

The Meritor bus and coach rear drive axles are available in the 59000, 61000, 71000 and RC-23-160 Series.

59000 Series

- Spiral bevel gearing is used in an angle drive carrier. The pinion is at a 63 angle to the axis of the axle shafts.
- Optional conventional single-reduction and double-reduction carriers with hypoid gearing are also available.
- A driveline parking brake is installed on the flange of some angle drive carriers.
- The housing is designed with replaceable axle tubes at the wheel spindles. Figure 2.1.

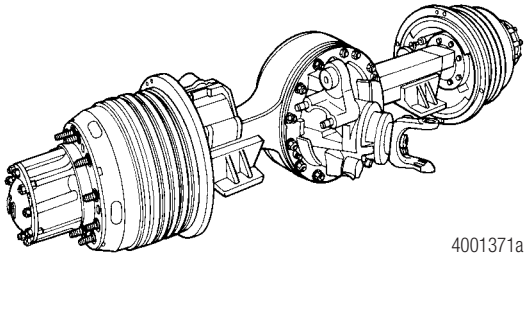


Figure 2.1

61000 Series

- The single-reduction carrier is combined with a hypoid drive pinion and a ring gear.
- Optional double-reduction carriers are also available.
- The housing is designed with replaceable axle tubes at the wheel spindles.
- The housing has weld-on torque rod brackets. Figure 2.2.

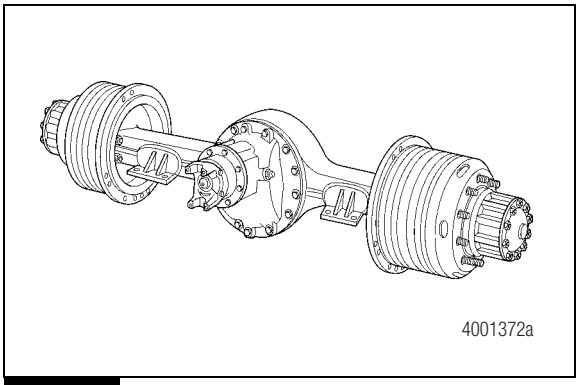


Figure 2.2

2 Introduction

71000 Series

- The single-reduction carrier is combined with a hypoid drive pinion and a ring gear.
- The housing is designed with replaceable axle tubes at the wheel spindles.
- The housing has bolt-on torque rod brackets. Figure 2.3.

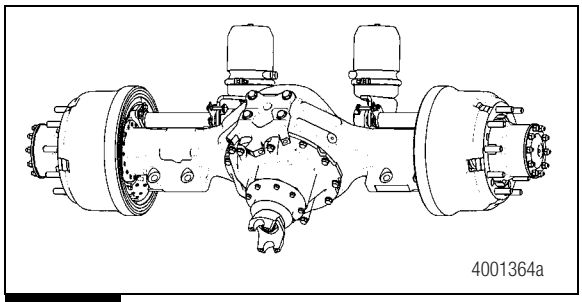


Figure 2.3

RC-23-160 Series

- The single-reduction carrier is combined with a hypoid drive pinion and a ring gear.
- The housing is designed without replaceable axle tubes at the wheel spindles. Figure 2.2.

Center Axles

The Meritor bus and coach center axles are available in the 61000, 71000 and RC-26-700 Series.

61000 and 71000 Series

- Center axles are identical to the 61000 and 71000 Series drive axles except without carriers or axle shafts.
- The spindle ends are capped so only the wheel end is filled with lubricant.
- A hubcap is used to keep lubricant in the wheel end instead of an axle shaft. Figure 2.4.

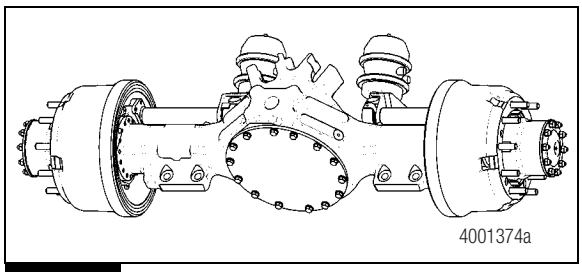


Figure 2.4

RC-26-700 Series

- Tubular deep-drop axles are designed for low floor applications. Figure 2.5.

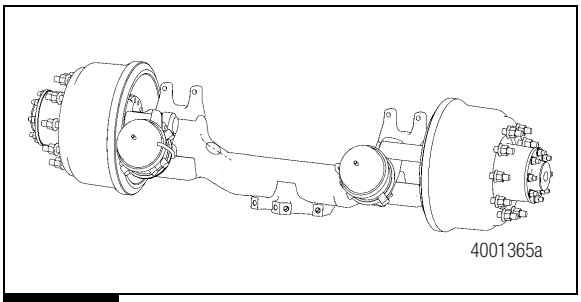


Figure 2.5

T Series Parking Brake

The 59000 Series parking brake is a Meritor T Series brake installed on the drive pinion bearing cage in the differential carrier.

- An air chamber with an automatic slack adjuster is attached to the parking brake camshaft.
- A brake drum is installed on the yoke flange.
- The brake assembly has an outer diameter of 12-inches (304 mm).
- The brake shoes are 4.5-inches (114 mm) wide. Figure 2.6.

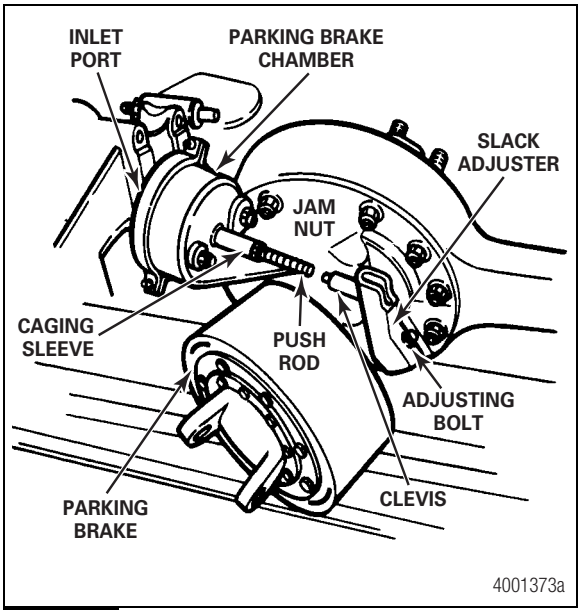


Figure 2.6

When the slack adjuster push rod moves, the camshaft rotates and moves the brake shoes against the drum.

Anchor pins allow the brake shoes to move. The anchor pins are fastened to the bearing cage with a lock screw and a lock wire. Each anchor pin has a replaceable bushing. A roller is installed into the cam end of each brake shoe. Rivets fasten a one-piece lining to each shoe. Figure 2.7.

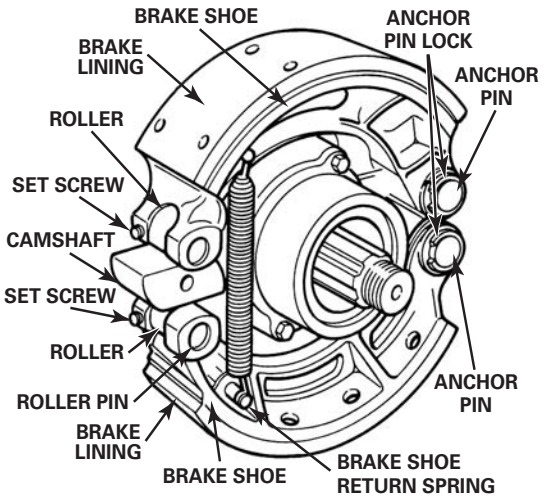


Figure 2.7

The camshaft is installed into bushings in the drive pinion bearing cage and the differential carrier. A fitting lubricates each bushing. The adjusting lever is installed onto the splined end of the camshaft. Figure 2.7.

Identification

Table A: Number Cross Reference

Previous Number	Current Number
59732	59752
59733	59753
61132	61152
61143	61153
	RC-23-160

An identification tag is located on the axle housing or the differential carrier. Use the model number and the ratio number marked on the tag to order replacement parts. Figure 2.8.

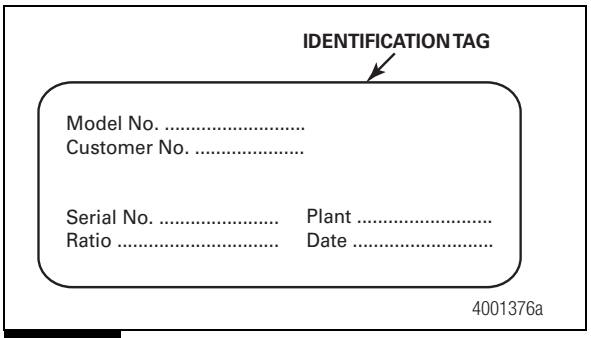


Figure 2.8

The model number designation for the 59000, 61000 and 71000 Series axles are identified in Figure 2.9 and Figure 2.10.

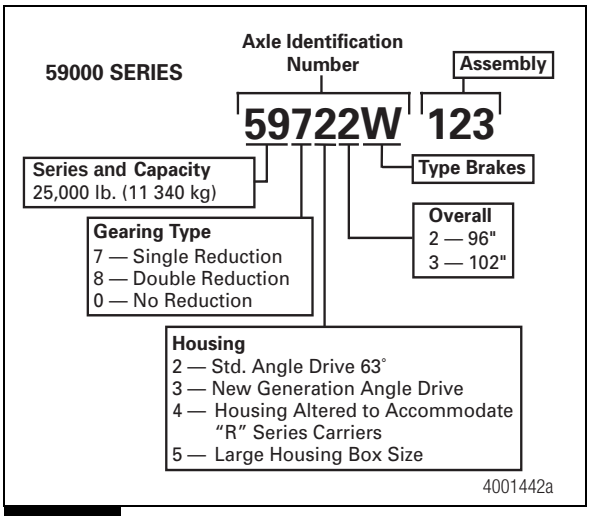


Figure 2.9

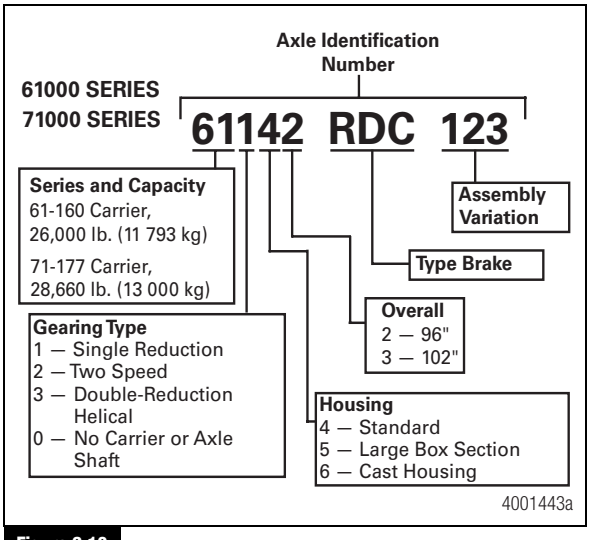


Figure 2.10

2 Introduction

The RC-23-160 coach rear axle is identified by a letter and number system that provides information about the specific axle model. The first seven positions of the designation identify a basic axle model. The second group of letters and numbers identify complete axle specifications. Figure 2.11.

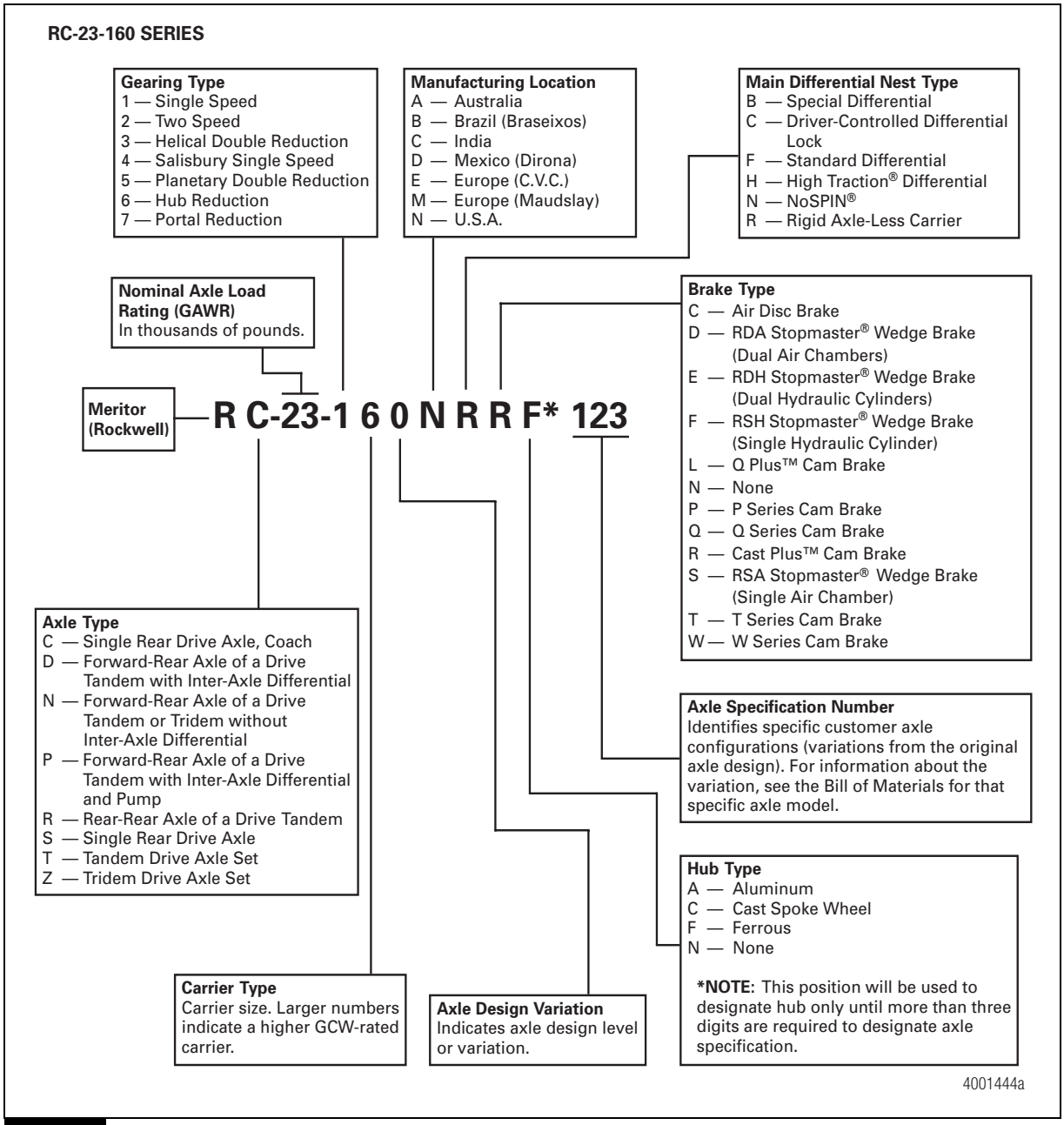


Figure 2.11

Hazard Alert Messages

Read and observe all Warning and Caution hazard alert messages in this publication. They provide information that can help prevent serious personal injury, damage to components, or both.

⚠ WARNING

To prevent serious eye injury, always wear safe eye protection when you perform vehicle maintenance or service.

Park the vehicle on a level surface. Block the wheels to prevent the vehicle from moving. Support the vehicle with safety stands. Do not work under a vehicle supported only by jacks. Jacks can slip and fall over. Serious personal injury and damage to components can result.

Use a brass or synthetic mallet for assembly and disassembly procedures. Do not hit steel parts with a steel hammer. Pieces of a part can break off. Serious personal injury and damage to components can result.

Removal

Differential Carrier from the Axle Housing

1. Park the vehicle on a level surface. Block the wheels not being serviced to prevent the vehicle from moving.
2. Use a jack to raise the vehicle so that the wheels to be serviced are off the ground. Support the vehicle with safety stands.
3. Place a drain pan under the axle housing.
4. Remove the drain plug from the bottom of the axle housing. Drain the lubricant from the assembly. Install the drain plug and tighten it to 35 lb-ft (47 N•m).

⚠ WARNING

Before you service a spring chamber, carefully follow the manufacturer's instructions to compress and lock the spring to completely release the brake. Verify that no air pressure remains in the service chamber before you proceed. Sudden release of compressed air can cause serious personal injury and damage to components.

5. Cage the spring in the parking brake air chamber. Refer to the air chamber manufacturer's procedure.
6. Remove the stud nuts and washers from the flanges of both axle shafts. Figure 3.1.

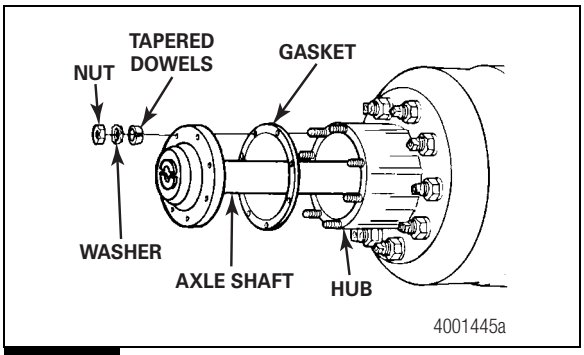


Figure 3.1

⚠ WARNING

Do not strike the round driving lugs on the flange of an axle shaft. Pieces can break off and cause serious personal injury.

⚠ CAUTION

Do not use a chisel or wedge to loosen the axle shafts and the dowels. Damage to the hub, the axle shafts and, if used, the oil seals can result.

7. If used, loosen the tapered dowels in the flanges of both axle shafts.
   A. Hold a 1.5-inch (38.1 mm) diameter brass drift or brass hammer against the center of the axle shaft inside the round driving lugs. Figure 3.2.
   B. Use a five-six lb (2.3-2.7 kg) hammer to strike the end of the drift to loosen the axle shaft and tapered dowels.

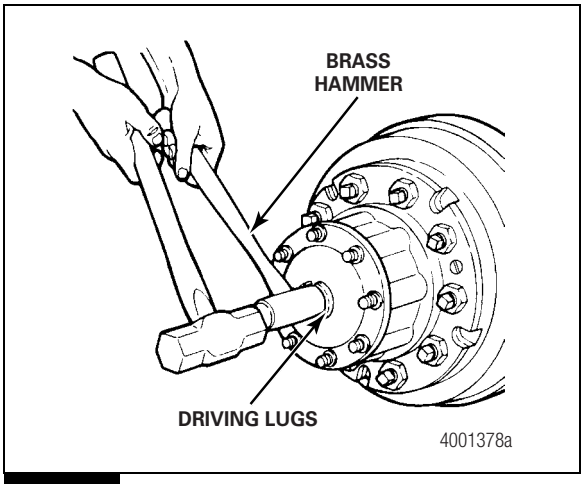


Figure 3.2

3 Removal and Disassembly

8. Remove the tapered dowels. Remove both axle shafts from the axle assembly.
9. Disconnect the drive shaft from the yoke.
10. Disconnect the air lines and the electrical connectors.
11. Place a hydraulic roller jack under the differential carrier to support the assembly. Figure 3.3.

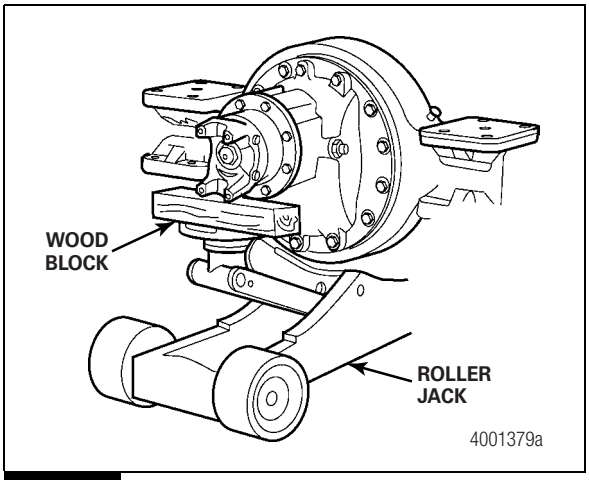


Figure 3.3

NOTE: Two capscrews or stud nuts and washers in the TOP of the carrier housing secure the carrier.

12. Remove all of the capscrews or stud nuts and washers that secure the carrier to the axle housing, except the two fasteners in the TOP of the carrier.
13. Loosen the two fasteners in the TOP of the carrier, but do not remove them.
14. Loosen the differential carrier by striking the mounting flange at several points with a leather mallet. Remove the two fasteners in the TOP of the carrier that secure the carrier to the axle housing.
15. Use a hydraulic roller jack and a pry bar with a round end to remove the carrier from the axle housing. Take care when you use the pry bar so that you don't damage the carrier or the housing flange.

⚠ WARNING

To avoid serious personal injury and damage to components, take care when using lifting devices during service and maintenance procedures. Inspect a lifting strap to ensure that it is not damaged. Do not subject the lifting straps to shocks or drop-loading.

NOTE: A carrier stand is available from SPX Kent-Moore. Refer to the Service Notes page on the front inside cover of this manual to obtain the stand.

16. Use a lifting tool to lift the differential carrier by the input yoke or the flange and place the assembly into a carrier repair stand. Figure 3.4.

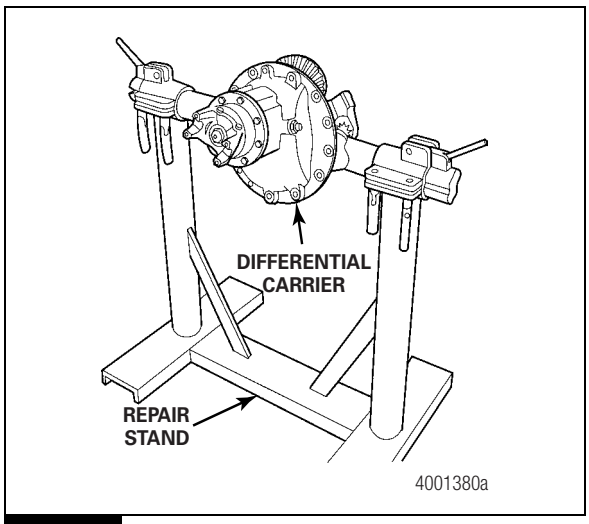


Figure 3.4

17. Place a holding tool on the yoke. Remove the nut that secures the yoke to the input shaft. Remove the washer.
18. Use a puller tool to remove the yoke.

NOTE: The POSE™ seal will remain on the yoke or the flange as the yoke or the flange is removed from the carrier.

19. If a POSE™ seal is on the hub, remove it from the hub with your hand.
20. If equipped, remove the parking brake. Refer to the procedure in this section.

21. Disassemble and assemble the differential carrier. For disassembly and assembly procedures for single-reduction carriers, refer to Maintenance Manual 5 or 5A, Single-Reduction Differential Carriers, or Maintenance Manual MM-0140, Single-Reduction Differential Carrier, Series 7. For optional carriers, refer to Maintenance Manual 6, Double-Reduction Differential Carriers. To obtain these publications, refer to the Service Notes page on the front inside cover of this manual.

Axle Shafts from the Axle Housing

1. Park the vehicle on a level surface. Block the wheels not being serviced to prevent the vehicle from moving.
2. Use a jack to raise the vehicle so that the wheels to be serviced are off the ground. Support the vehicle with safety stands.
3. For drive axles, remove the stud nuts and the washers from the flanges of both axle shafts. For center axles, remove the nuts and the washers from both hubcaps. Remove the hubcaps. Figure 3.5.

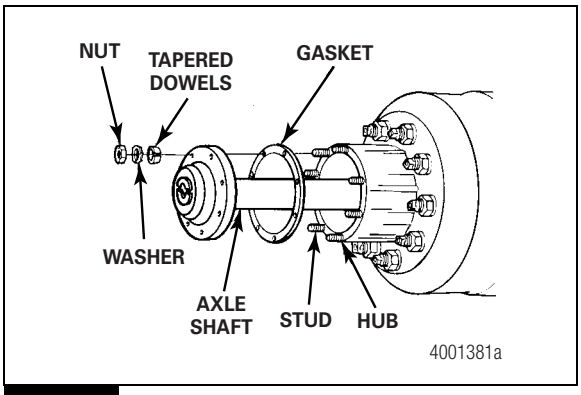


Figure 3.5

4. For drive axles, loosen the tapered dowels in the flanges of both axle shafts using one of the following methods.

Brass Drift Method

⚠ WARNING

Do not strike the round driving lugs on the flange of an axle shaft. Pieces can break off and cause serious personal injury.

1. Hold a 1-1/2-inch (38 mm) diameter brass drift or hammer against the center of the axle shaft, inside the round driving lugs. Figure 3.6.

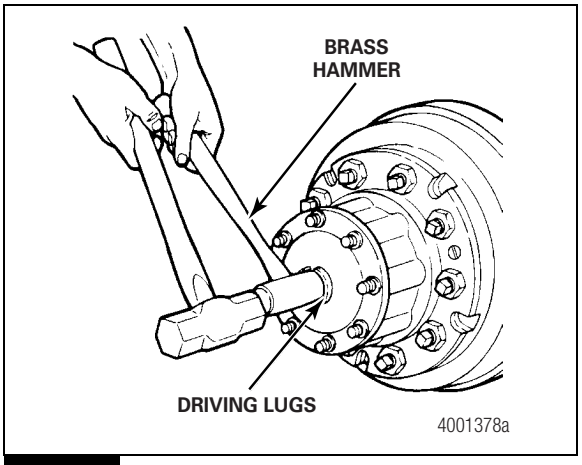


Figure 3.6

2. Use a five-six lb (2-3 kg) hammer to strike the end of the drift to loosen the axle shaft and the tapered dowels.
3. Mark each axle shaft before it is removed from the axle assembly.
4. Remove the tapered dowels and separate the axle shafts from the main axle hub assembly. Figure 3.5.
5. Install a cover over the open end of each axle assembly hub where an axle shaft was removed.

Air Hammer Vibration Method

⚠ WARNING

Wear safe eye protection when using an air hammer. When using power tools, axle components can loosen and break off causing serious personal injury.

⚠ CAUTION

Do not use a chisel or a wedge to loosen the axle shafts and the dowels. Damage to the hub, the axle shafts and, if used, the oil seals can result.

1. Use a round hammer bit and an air hammer to loosen the tapered dowels and the axle shaft.
2. Place the round hammer bit against the axle shaft, flange, between the hub studs. Operate the air hammer at alternate locations between the studs to loosen the tapered dowels and the axle shaft from the hub. Figure 3.7.

3 Removal and Disassembly

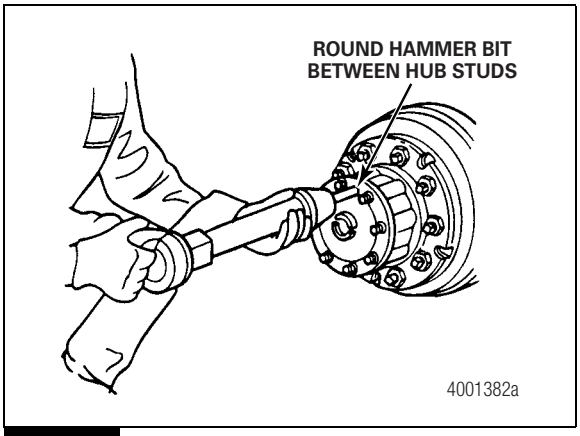


Figure 3.7

3. Mark each axle shaft before it is removed from the axle assembly.
4. Remove the tapered dowels and separate the axle shaft from the main axle hub assembly. Figure 3.6.

Hub and Drum Assembly or Hub and Rotor Assembly from the Axle Housing

⚠ WARNING

Before you service a spring chamber, carefully follow the manufacturer's instructions to compress and lock the spring to completely release the brake. Verify that no air pressure remains in the service chamber before you proceed. Sudden release of compressed air can cause serious personal injury and damage to components.

1. Cage the spring in the parking brake air chamber. Refer to the air chamber manufacturer's procedure.

⚠ WARNING

When you perform a wheel bearing adjustment, observe the following guidelines.

- **Always use the correct size wrench socket.**
- **Always use a torque wrench to tighten the adjusting nuts to the correct adjusting torque.**
- **Do not tighten or loosen the adjusting nuts by hitting the nuts with a hammer or by hitting a chisel or a drift placed against the nuts with a hammer. Damage to the nuts can result. Damaged adjusting nuts can prevent a correct wheel bearing adjustment, cause possible loss of vehicle wheel-end equipment and cause serious personal injury.**

2. For optional grease-lubricated wheel ends, remove the grease seal on the outboard end of the hub. Discard the seal. Figure 3.8.

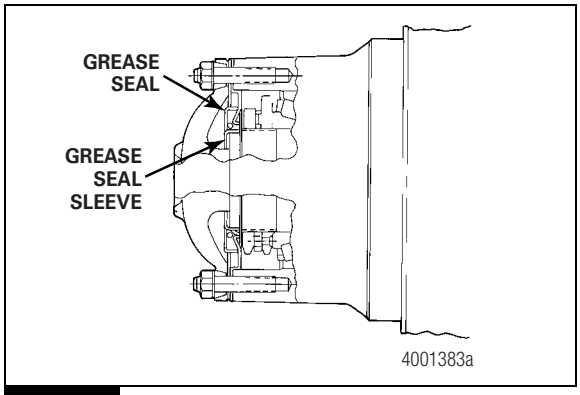


Figure 3.8

3. If equipped, straighten the stamped retainer from the outer wheel bearing nut. Remove the outer wheel bearing nut, stamped retainer, lock washer and inner wheel bearing nut from the spindle. Figure 3.9.

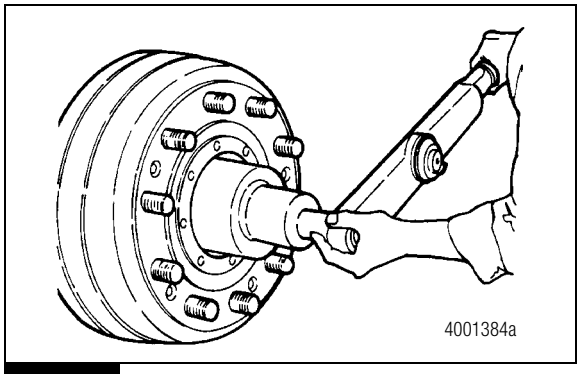


Figure 3.9

NOTE: You can remove the hub, drum or rotor, and wheel assembly as an assembly. To support the weight, use an appropriate wheel dolly.

4. Pull the hub, drum or rotor, and wheel assembly STRAIGHT off the spindle. If necessary, hit the inside of the wheel with a mallet to loosen it. Be careful that the outer bearing cone does not fall when the hub is removed.

Disassembly

⚠ WARNING

Observe all warnings and cautions provided by the press manufacturer to avoid damage to components and serious personal injury.

Hub Assembly Without ABS: 59000, 61000, 71000 and RC-26-700 Series

1. Remove the wheel and tire assembly from the hub.
2. To disassemble the drum from the hub, remove the flat-head capscrews from the drum, if equipped.

⚠ WARNING

Do not hit the wheel studs with a steel hammer or remove the studs by twisting. Damage to the parts can occur and metal fragments can cause serious personal injury.

3. If it is necessary to remove the wheel studs from the hub, remove the nuts from the inside of the hub flange. Remove the oil deflector, if equipped. Place the hub into a press with the drum mounting surface supported by the press. Press the studs through the hub. If a press is not available, use a brass hammer or a drift.
4. The wheel seal is in a seal retainer. If you are only removing the oil seal, use a long screwdriver to remove the oil seal from the hub. Discard the old seal. Figure 3.10.

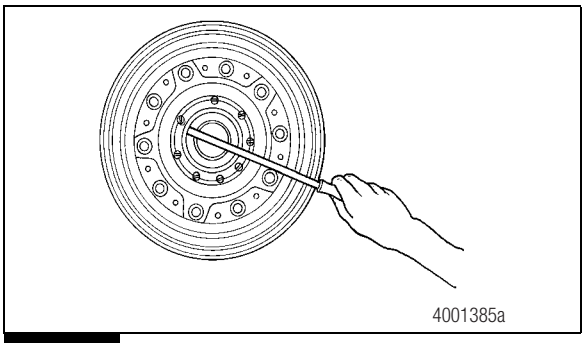


Figure 3.10

5. To remove the inner bearing cone, remove the screws that secure the seal retainer to the hub and remove the seal retainer.
6. Use a press and a sleeve, or a bearing puller, to remove the inner and the outer bearing cups from the hub. Remove the oil seal sleeve from the axle housing.
7. For optional grease-lubricated wheel ends, remove the grease seal sleeve from the end of the spindle.

Hub Assembly with ABS: 59000, 61000, 71000 and RC-26-700 Series

1. Remove the wheel and tire assembly from the hub.
2. To remove the drum from the hub, remove the flat-head capscrews from the drum, if equipped.
3. If it is necessary to remove the wheel studs from the hub, remove the nuts from the inside of the hub flange. Remove the oil deflector, if used. Place the hub into a press with the drum mounting surface supported by the press. Press the studs through the hub. Figure 3.11.

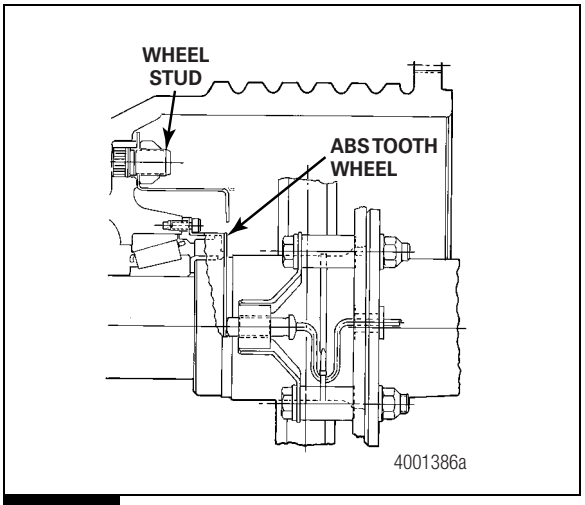


Figure 3.11

4. The wheel seal is located in a seal retainer located below the ABS tooth wheel. Remove the capscrews that secure the ABS tooth wheel and the seal retainer to the hub. Figure 3.11.
5. Use a press and a suitable driver to remove the oil seal from the seal retainer. Discard the old seal.
6. Remove the inner bearing cone from the hub.

3 Removal and Disassembly

7. Use a press and a sleeve, or a bearing puller, to remove the inner and the outer bearing cups from the hub.
8. Remove the oil seal sleeve from the axle housing.
9. For optional grease-lubricated wheel ends, remove the grease seal sleeve from the end of the spindle.

Hub Assembly with Drum Brakes: RC-23-160 Series

1. Remove the wheel and tire assembly from the hub.
2. Remove the brake drum.
3. If it is necessary to remove the wheel studs from the hub, place the hub into a press. Support the hub flange and press the studs through the hub. If a press is not available, use a brass hammer or a drift.

⚠ WARNING

Do not hit the wheel studs with a steel hammer or remove the studs by twisting. Damage to the parts can occur and metal fragments can cause serious personal injury.

4. If necessary, use a long screwdriver to remove the oil seal from the hub. Discard the oil seal. Figure 3.12.

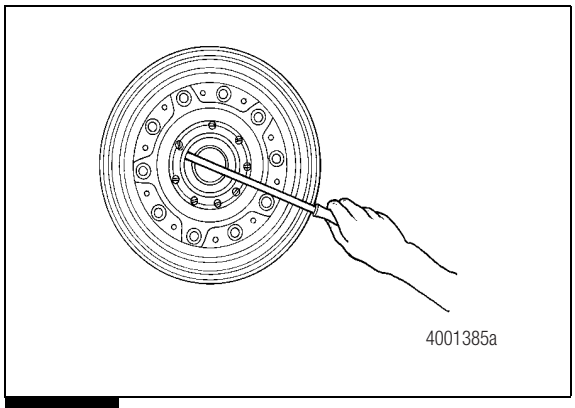


Figure 3.12

5. Remove the inner bearing cone from the hub.
6. Use a press and a sleeve, or a bearing puller, to remove the inner and the outer bearing cups from the hub.

⚠ CAUTION

If not removed, protect the ABS tone wheel to prevent the teeth from being nicked or damaged while handling the hub.

7. If necessary, use a suitable puller to remove the ABS tooth wheel from the hub.

Hub Assembly with Disc Brakes: RC-23-160 Series

1. Remove the wheel and tire assembly from the hub.
2. If it is necessary to remove the rotor, remove the 10 socket-head capscrews that secure the rotor to the hub. Remove the rotor from the hub. Figure 3.13.

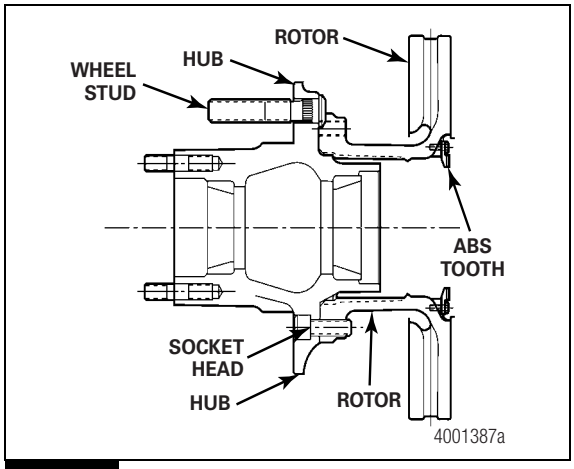


Figure 3.13

⚠ CAUTION

If not removed, protect the ABS tooth wheel to prevent the teeth from being nicked or damaged while handling the hub.

3. If necessary, remove the ABS tooth wheel from the rotor by removing the retaining capscrews.

⚠ WARNING

Do not hit the wheel studs with a steel hammer or remove the studs by twisting. Damage to the parts can occur and metal fragments can cause serious personal injury.

4. If it is necessary to remove the wheel studs from the hub, place the hub into a press. Support the hub flange and press the studs through the hub. If a press is not available, use a brass hammer or a drift.

5. If necessary, use a long screwdriver to remove the oil seal from the hub. Discard the oil seal. Figure 3.14.

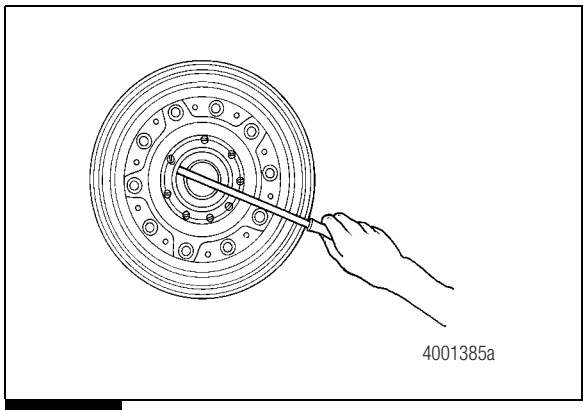


Figure 3.14

6. Remove the inner bearing cone from the hub.
7. Use a press and a sleeve, or a bearing puller, to remove the inner and the outer bearing cups from the hub.

Brakes from the Housing Without ABS: 59000, 61000, 71000 and RC-26-700 Series

1. Disassemble the brake. Refer to Maintenance Manual 23B, Bus and Coach Brakes. To obtain this publication, refer to the Service Notes page on the front inside cover of this manual.
2. Remove the bolts, nuts and washers that secure the brake spider to the housing.
3. Drill out the rivets that secure the brake spider to the housing. Verify that the spider and the housing are not damaged.
4. Remove the brake spider from the housing.

Brakes from the Housing: 59000, 61000, 71000 and RC-26-700 Series with ABS

1. Disassemble the brake. Refer to Maintenance Manual 23B, Bus and Coach Brakes. To obtain this publication, refer to the Service Notes page on the front inside cover of this manual.
2. Remove the bushing on the ABS sensor cable where the cable comes through the housing brake flange. Figure 3.15.

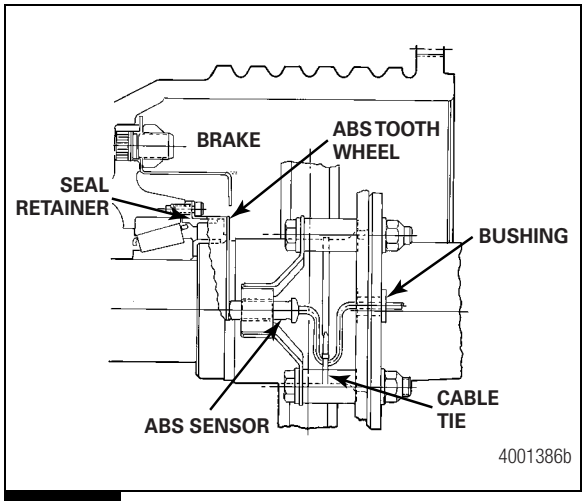


Figure 3.15

3. Cut the cable tie.
4. Pull the cable through the brake flange.
5. If required, remove the hose clamp that secures the ABS block to the housing.
6. Remove the bolts, nuts and washers that secure the brake spider to the housing.
7. If required, remove the ABS block mounting capscrews. Figure 3.16.

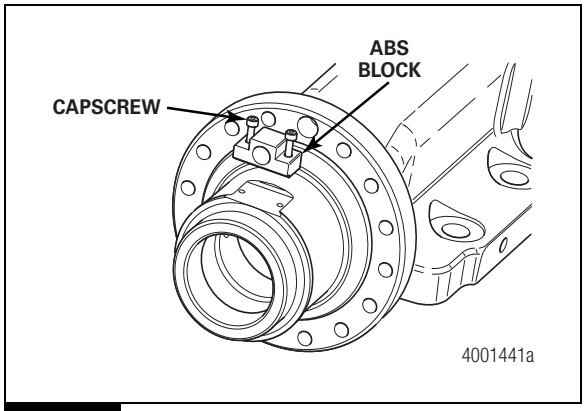


Figure 3.16

3 Removal and Disassembly

8. Use hand pressure to disassemble the ABS sensor from the ABS spring clip and the ABS support bracket. Figure 3.17.

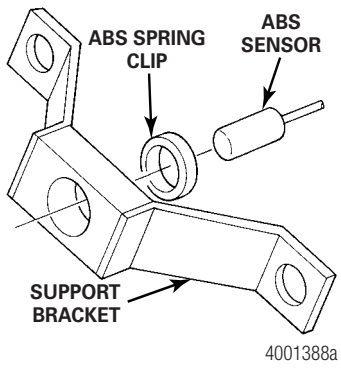


Figure 3.17

9. Drill out the rivets that secure the brake spider to the housing. Verify that the spider and the housing are not damaged.
10. Remove the brake spider from the housing.

Drum Brakes from the Housing: RC-23-160 Series

1. Disassemble the brake. Refer to Maintenance Manual 23B, Bus and Coach Brakes. To obtain this publication, refer to the Service Notes page on the front inside cover of this manual.
2. Disassemble the ABS sensor block from the housing by removing the two socket-head capscrews that secure the upper block to the lower block.
3. Use your hand to remove the ABS sensor from the bushing and the upper block.

Disc Brakes from the Housing: RC-23-160 Series

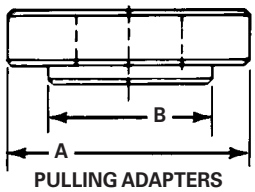
1. Remove the brake caliper from the torque plate. Refer to the brake manufacturer's procedure.
2. Remove the ABS sensor from the torque plate.
3. Use your hand to remove the ABS sensor from the bushing and the upper block.
4. Remove the bolts, nuts and washers that secure the brake spider or the torque plate to the housing.
5. Remove the brake spider or the torque plate from the housing.

Removal

Axle Tube: 59000, 61000 and 71000 Series

The following tools are required to remove and install the axle tube. The tools are available from the Wright Tool Company. The adapters, clamping strap and pilot plate must be ordered separately. To obtain these tools, refer to the Service Notes page on the front inside cover of this manual.

- Tool set WTC HY-100 includes a hydraulic ram, two-speed hydraulic pump, puller tube, two puller screws, connecting nut, hex nut, speed nut and electric hydraulic pump.
- Two pulling adapters: Measure dimension "A" and "B" on the axle tube. The adapter outer diameter must be slightly smaller than the tube outer diameter. Figure 3.18.
- Tube adapter: Measure dimension "A" on the axle tube. The tube adapter inner diameter must be slightly larger than the tube outer diameter. Figure 3.19.
- One pilot plate and one clamping strap: The pilot plate prevents the axle housing from collapsing when the tube is installed. Measure dimension "A" in the axle housing. The clamping strap fits all pilot plates. Figure 3.20 and Figure 3.21.

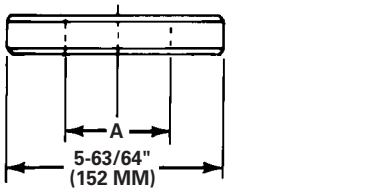


PULLING ADAPTERS

Part Number	"A" inches (mm)	"B" inches (mm)
100-1	2.812 (71.425)	2.312 (58.725)
100-2	2.531 (64.287)	2.000 (50.800)
100-3	3.844 (97.637)	3.062 (77.775)
100-4	3.344 (84.937)	2.531 (64.287)
100-5	3.719 (94.463)	3.156 (80.162)
100-6	3.219 (81.763)	2.406 (61.112)
100-7	3.219 (81.763)	2.156 (54.762)
100-8	3.375 (85.725)	2.531 (64.287)
100-9	3.281 (83.337)	2.531 (64.287)
100-10	2.781 (70.637)	2.312 (58.725)
100-11	3.719 (94.463)	3.312 (84.125)
100-12	3.719 (94.463)	3.125 (79.375)
100-13	3.469 (88.113)	2.406 (61.112)
100-14	3.781 (70.637)	3.125 (79.375)
100-15	3.781 (70.637)	3.312 (84.125)
100-16	3.844 (97.637)	3.312 (84.125)
100-17	3.844 (97.637)	3.125 (79.375)

4001389a

Figure 3.18

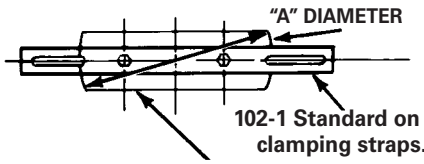


TUBE ADAPTERS

Part Number	"A" Tube Diameter inches (mm)
101-1	3.000 (76.2)
101-2	2.688 (68.275)
101-3	4.500 (114.3)
101-4	3.594 (91.288)
101-5	3.250 (82.55)
101-6	3.188 (80.975)
101-7	3.500 (88.9)

4001390a

Figure 3.19



103-1 etc. Customer to check size of housing carrier bore size carrier pilot plate.

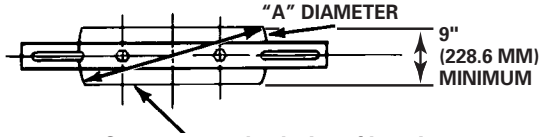
CARRIER PILOT PLATES

Part Number	"A" Carrier Bore Diameter inches (mm)
103-1	11.125 (282.575)
103-2	13.250 (336.55)
103-3	13.500 (342.9)
103-4	15.375 (390.525)
103-5	15.500 (393.7)
103-6	15.625 (396.875)
103-7	16.000 (406.4)
102-1	Clamping Strap

4001391a

Figure 3.20

FOR CAST HOUSINGS



103-1 etc. Customer to check size of housing carrier bore size carrier pilot plate.

CARRIER PILOT PLATES

Part Number	"A" Carrier Bore Diameter inches (mm)
Contact supplier for part numbers.	16.716 (424.6)
	Clamping Strap

4001391b

Figure 3.21

1. Remove the tire and wheel assembly and the hub and drum assembly. Refer to the manufacturer's procedure.
2. Remove the axle shafts and the differential carrier. Refer to the procedure in this section.
3. For models with a cast housing, a dowel is located on the axle centerline on the carrier side of the spindle. Drill a 0.5-inch (13 mm) diameter hole in the middle of the dowel. The hole should be 0.63-0.79-inch (16-20 mm) deep. Tap the hole and use a puller to remove the dowel.
4. Install the pulling adapter into each end of the axle tube. Figure 3.22.

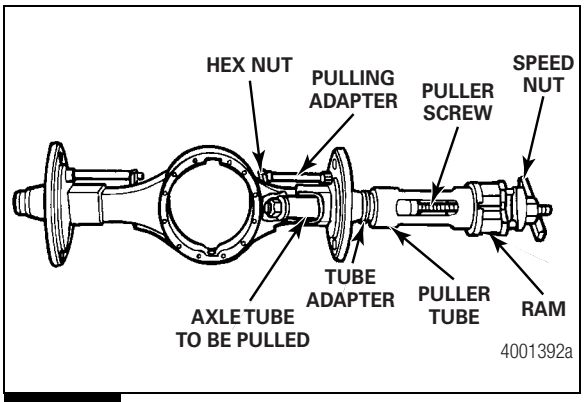


Figure 3.22

5. Place the tube adapter into the hub side of the axle tube. Figure 3.22.
6. Install the puller tube against the tube adapter. Figure 3.22.
7. Connect the hydraulic ram to the puller tube. Install the speed nut onto the hydraulic ram. Figure 3.22.
8. Connect the hydraulic ram to the hydraulic pump. Apply pressure and remove the axle tube from the housing. Figure 3.22.

3 Removal and Disassembly

Parking Brake Shoes

1. Park the vehicle on a level surface. Block the wheels to prevent the vehicle from moving.
2. Release the brake system air pressure.

⚠ WARNING

Before you service a spring chamber, carefully follow the manufacturer's instructions to compress and lock the spring to completely release the brake. Verify that no air pressure remains in the service chamber before you proceed. Sudden release of compressed air can cause serious personal injury and damage to components.

3. Cage the spring in the spring chamber, if used. Refer to the spring chamber manufacturer's procedure.
4. Remove the bolts and the washers that secure the brake drum to the flange on the yoke. Slide the drum onto the drive shaft. Figure 3.23.

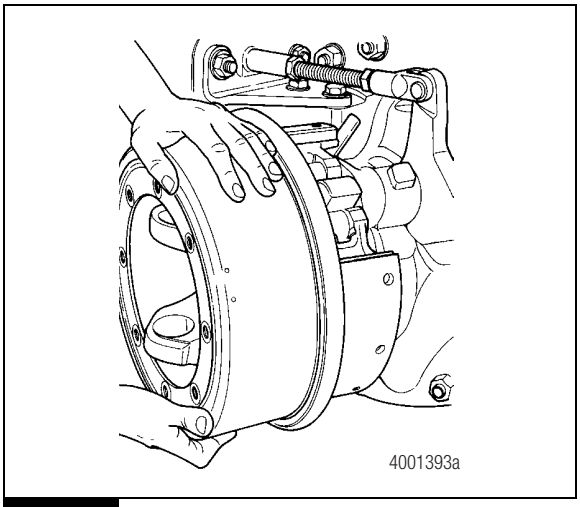


Figure 3.23

5. To remove the brake drum, disconnect the drive shaft. Remove the brake drum.
6. Remove the spring from the brake shoes. Figure 3.24.

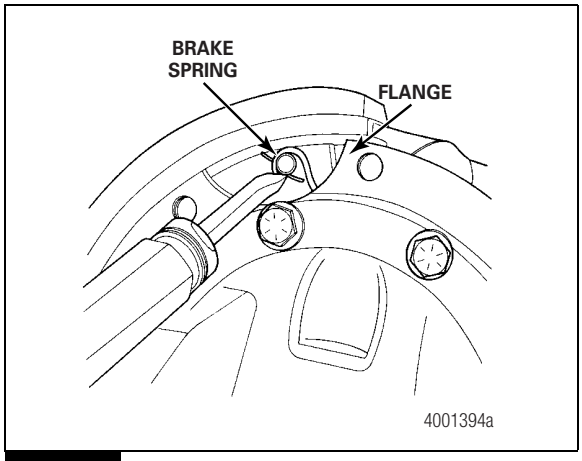


Figure 3.24

7. Remove the lock that secures the shoe to the anchor pin. Remove the oil seal retainer and the oil seal from the anchor pin. Figure 3.25.

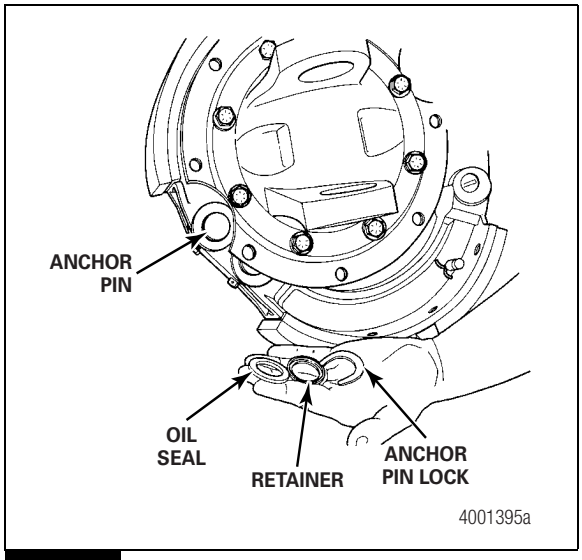


Figure 3.25

8. Remove the lock wire from the anchor pin. Loosen the lock screws for the anchor pin.
9. Use a brass drift and a punch to remove the anchor pin from the bearing cage. Remove the brake shoes. Figure 3.26.

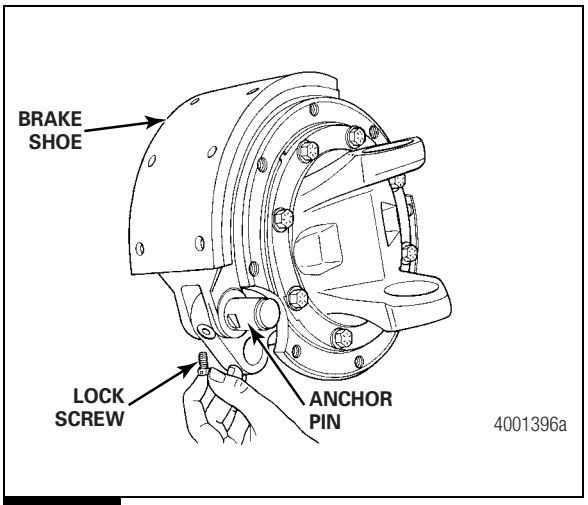


Figure 3.26

10. If necessary, remove the cam roller. Remove the set screw that secures the shaft to the shoe. Remove the roller and the shaft from the shoe. Figure 3.27.

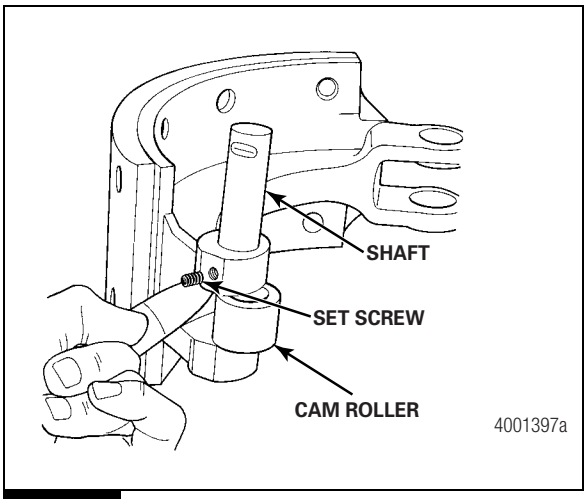


Figure 3.27

Camshaft

1. Remove the brake shoes and the drum. Refer to the procedure in this section.
2. Remove the yoke from the drive pinion. Refer to the procedure in this section.
3. Disconnect the parking brake linkage from the adjusting lever.
4. Remove the snap ring and the washers that secure the adjusting lever to the camshaft. Remove the lever. Figure 3.28.

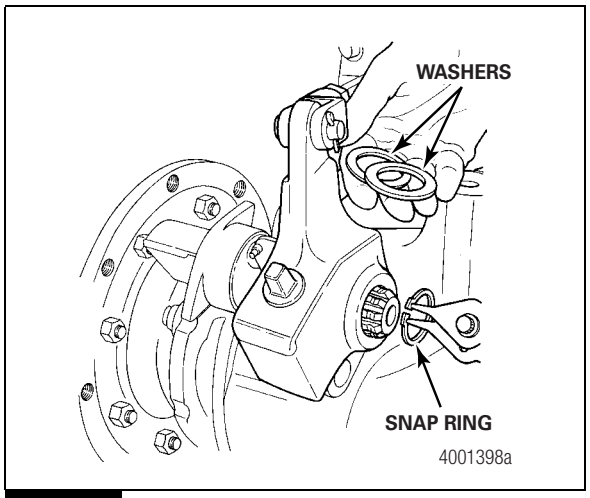


Figure 3.28

5. Remove the camshaft from the front of the bearing cage. Figure 3.29.

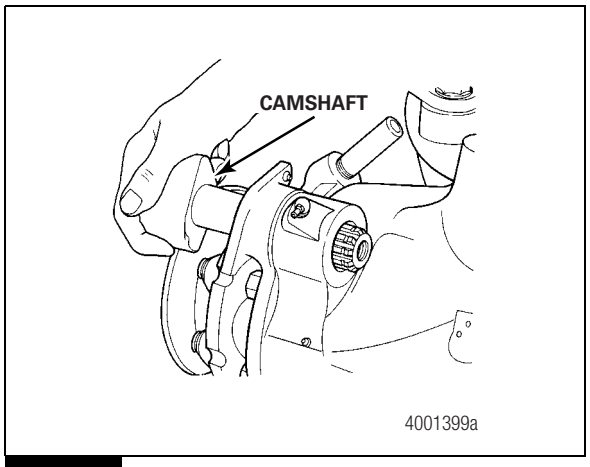


Figure 3.29

6. If worn or damaged, remove the oil seal in the bearing cage.
7. If worn or damaged, replace the camshaft bushings in the differential carrier and the bearing cage. Use a hammer and a driver tool to remove the bushings.

3 Removal and Disassembly

Torque Rod Brackets: 61000 Series Axles with Cast Housing and 71000 Series Axles

1. Remove the bolts and the washers that secure the torque rod bracket to the housing.
2. The bracket is connected to the housing with a press-fit dowel. Pull the bracket perpendicular to the mounting surface to remove the bracket. It may be necessary to rotate the bracket around the dowel while pulling to remove the bracket.
3. Remove the dowel from the housing.
   - **If any of the threaded holes in the housing are stripped or the dowel hole is elongated out-of-round:** Replace the housing.

Hazard Alert Messages

Read and observe all Warning and Caution hazard alert messages in this publication. They provide information that can help prevent serious personal injury, damage to components, or both.

⚠ WARNING

To prevent serious eye injury, always wear safe eye protection when you perform vehicle maintenance or service.

⚠ ASBESTOS AND NON-ASBESTOS FIBERS WARNING

Some brake linings contain asbestos fibers, a cancer and lung disease hazard. Some brake linings contain non-asbestos fibers, whose long-term effects to health are unknown. You must use caution when you handle both asbestos and non-asbestos materials.

⚠ WARNING

Solvent cleaners can be flammable, poisonous and cause burns. Examples of solvent cleaners are carbon tetrachloride, and emulsion-type and petroleum-base cleaners. Read the manufacturer's instructions before using a solvent cleaner, then carefully follow the instructions. Also follow the procedures below.

- **Wear safe eye protection.**
- **Wear clothing that protects your skin.**
- **Work in a well-ventilated area.**
- **Do not use gasoline, or solvents that contain gasoline. Gasoline can explode.**
- **You must use hot solution tanks or alkaline solutions correctly. Read the manufacturer's instructions before using hot solution tanks and alkaline solutions. Then carefully follow the instructions.**

Clean, Dry and Inspect Parts

Ground and Polished Parts

Use a cleaning solvent to clean ground or polished parts or surfaces. Kerosene or diesel fuel oil can be used for this purpose. DO NOT USE GASOLINE.

- Do NOT clean ground or polished parts in a hot solution tank, water, steam or alkaline solutions.
- Use a knife, if required, to remove gasket material from parts. Be careful not to damage the ground or polished surfaces.

Rough Parts

Rough parts can be cleaned with cleaning solvent or in a hot solution tank with a weak alkaline solution.

Parts must remain in hot solution tanks until completely cleaned and heated.

When removed from the hot solution, wash the parts with water until the alkaline solution is removed.

Dry Cleaned Parts

Parts must be dried immediately after cleaning and washing.

Dry the parts using soft clean paper or cloth rags.

⚠ CAUTION

Bearings can be damaged if dried by rotating with compressed air.

Except for bearings, parts can be dried with compressed air. Do not dry bearings by spinning with compressed air.

Prevent Corrosion on Cleaned Parts

Apply a light oil to cleaned and dried parts that are not damaged and are to be immediately assembled.

If parts are to be stored, apply a good corrosion preventative to all surfaces. Store the parts inside special paper or other material that prevents corrosion.

Inspect Parts

Tapered Roller Bearings

Inspect the cup, cone, rollers and cage of all tapered roller bearings in the assembly. If you find any of the following conditions, replace the bearing.

- The center of the large-diameter end of the rollers is worn level or below the outer surface.

4 Prepare Parts for Assembly

- The radius at the large-diameter end of the rollers is worn to a sharp edge. Figure 4.1.

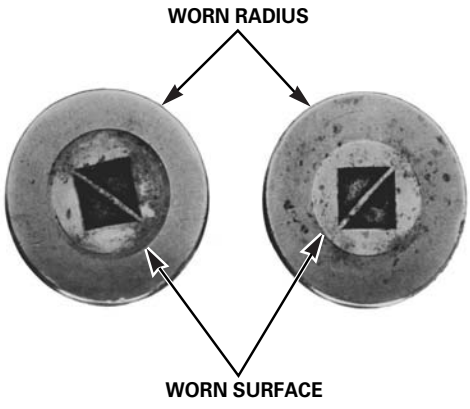


Figure 4.1

- You find a roller groove at the small- or large-diameter end of the cup or cone inner race surfaces.
- You can see deep cracks or breaks in the cup, cone, and inner race or roller surfaces. Figure 4.2.

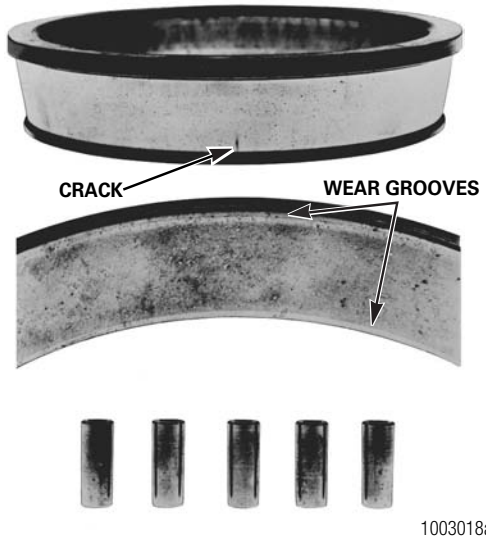


Figure 4.2

- You can see bright wear marks on the outer surface of the roller cage. Figure 4.3.

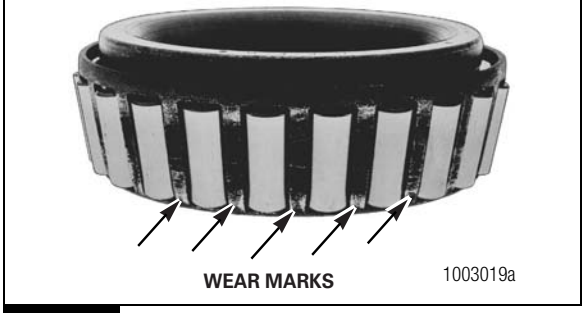


Figure 4.3

- The rollers are damaged. Figure 4.4.

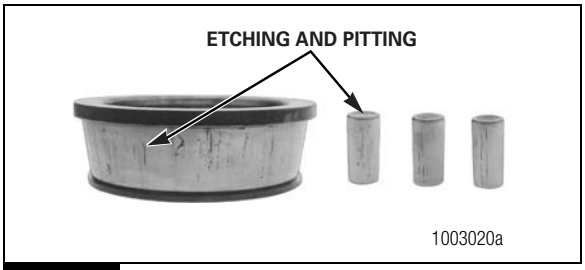


Figure 4.4

- The cup and cone inner race surfaces that touch the rollers are damaged. Figure 4.5.

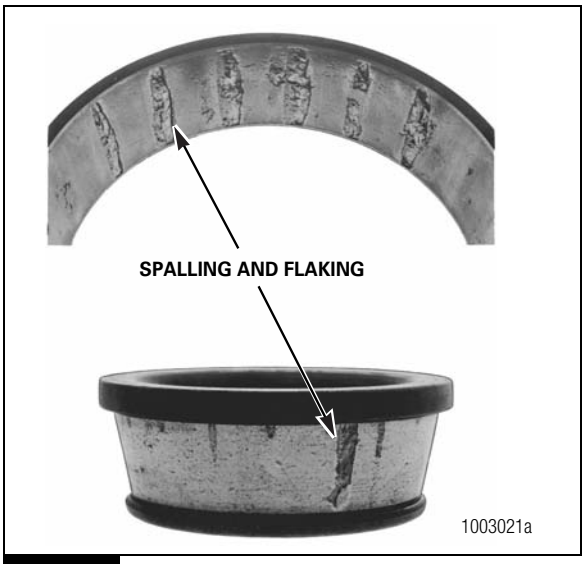


Figure 4.5

Brakes

Meritor recommends that you replace the following parts at each reline.

- Springs
- Clevis pins
- Rollers
- Camshaft seals
- Anchor pins

For additional brake information, refer to Maintenance Manual 23B, Bus and Coach Brakes. To obtain this publication, refer to the Service Notes page on the front inside cover of this manual.

Brake Drums

Replace a drum if the drum is cracked, worn or damaged.

- **If a drum is out-of-round:** Remove material from the inside of the drum.
- **If the inner diameter of a drum is more than 12.09-inches (307 mm):** Replace the drum.

Bushings and Linings

Replace the linings if they are worn to the top of the rivet.

Replace the bushings if they are worn or damaged.

Camshaft

If the camshaft is worn or damaged, replace the camshaft.

Replace the camshaft bushings if they are worn or damaged.

Disc Brake Caliper and Brake Pads

Refer to the brake manufacturer's inspection procedures.

Disc or Rotor

⚠ WARNING

You must replace a damaged disc. The brake system may not operate correctly. Damage to components and serious personal injury can result.

When you reline the brakes, you must measure the thickness of the disc.

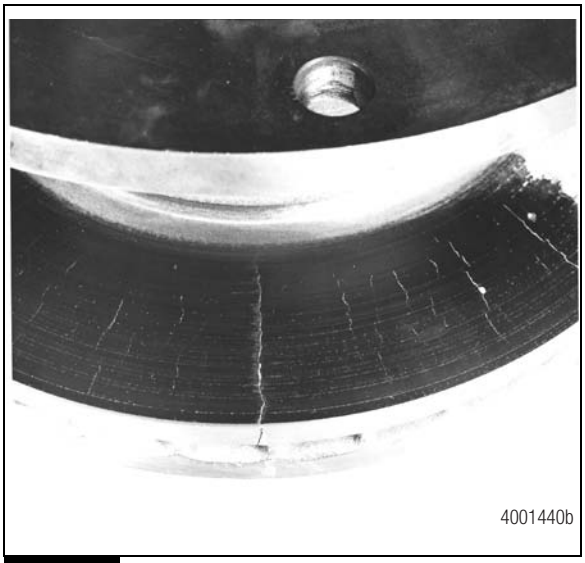
When you inspect the brakes, also inspect both sides and the outer diameter of the disc. Inspect for the following.

- Cracks
- Heat checking
- Grooves or scores
- Blue marks or bands

Cracks

A crack can extend through a section of the disc and can cause the two sides of the crack to separate. Figure 4.6.

- **If you find any cracks:** Replace the disc.



4001440b

Figure 4.6

4 Prepare Parts for Assembly

Heat Checking

Heat checking produces cracks in the surface of the disc. Heat checking can be light or heavy. Light heat checking is very fine, tight, small cracks. Light heat checking is normal. You can continue to use a disc with light heat checking. Heavy heat checking produces surface cracks that have width and depth. Figure 4.7.

- **If you find heavy heat checking:** Replace the disc.

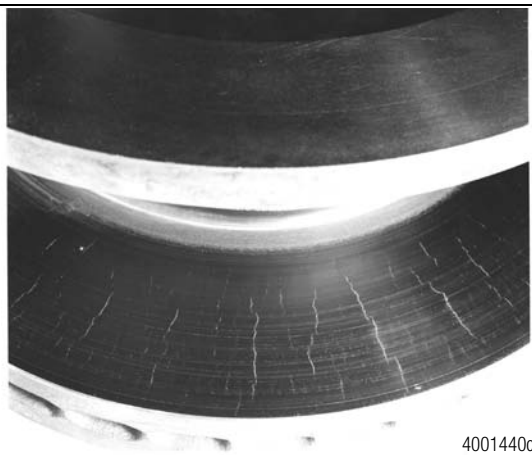


Figure 4.7

Grooves or Scores

Check both sides of the disc for deep grooves or scores. Light scoring is normal in rotors. Figure 4.8.

- **If the grooves or scores are deep:** Replace the disc.

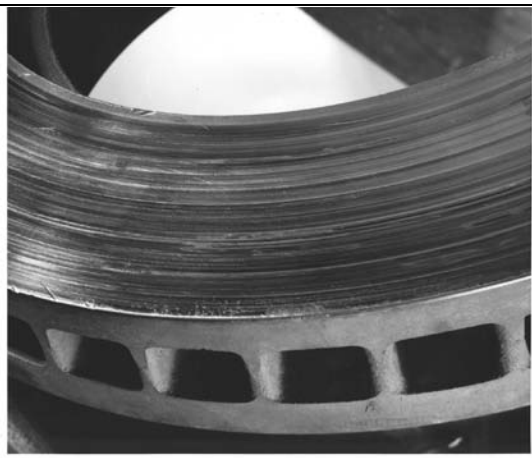


Figure 4.8

Blue Marks or Bands

Blue marks or bands indicate that the disc was very hot. Figure 4.9.

- **If blue marks or bands are present:** Check for dragging brake linings or severe overloading.

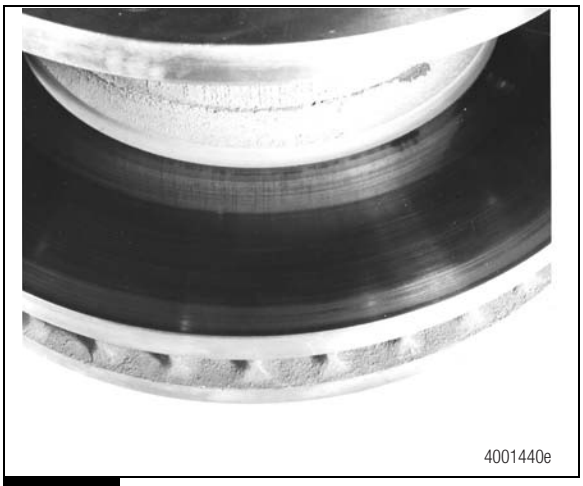


Figure 4.9

Measure the Disc Thickness

Measure the disc thickness when you reline the brakes. Discs with vents must be at least 1.626-inches (41.3 mm) thick. Figure 4.10.

- **If the disc thickness is less than the specification:** Replace the disc.

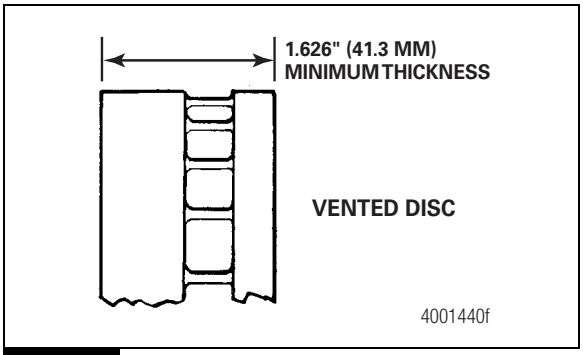


Figure 4.10

Applying Adhesive and Silicone Gasket Material

Silicone Gasket Material

⚠ WARNING

When you apply some silicone gasket materials, a small amount of acid vapor is present. To prevent serious personal injury, ensure that the work area is well-ventilated. Read the manufacturer's instructions before using a silicone gasket material, then carefully follow the instructions. If a silicone gasket material gets into your eyes, follow the manufacturer's emergency procedures. Have your eyes checked by a physician as soon as possible.

Take care when you use Loctite® adhesive to avoid serious personal injury. Read the manufacturer's instructions before using this product. Follow the instructions carefully to prevent irritation to the eyes and skin.

NOTE: You can use the following silicone gasket products, or equivalent, on Meritor components.

The following products are available in three oz. (85 gram) tubes.

- Three Bond Liquid Gasket number TB 1216 (Grey), Meritor part number 2297-Z-7098
- Loctite® Ultra Grey Flange Sealant number 5699, Meritor part number 2297-A-7021

The following product is available in 120 oz. (3.4 kg) cartridges.

- Three Bond RTV1216 (Grey), Meritor part number 2297-A-7051

1. Remove all old gasket material from both surfaces.
2. Clean the surfaces where you'll apply the silicone gasket material. Remove all oil, grease, dirt and moisture. Dry both surfaces.
3. Apply a 0.125-inch (3.18 mm) diameter continuous bead of silicone gasket material around one surface. Also apply the gasket material around the edge of all the fastener holes on that surface. Figure 4.11.

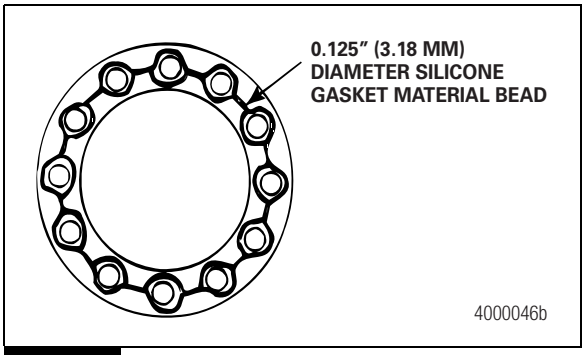


Figure 4.11

4. Assemble the components immediately to permit the gasket material to compress evenly between the parts.
5. Tighten the fasteners to the required torque specification for that size fastener. Refer to Section 7.
6. Wait 20 minutes before filling the assembly with lubricant. Refer to Section 7.

Repair Welding on Axle Housings

For complete repair welding instructions, refer to Maintenance Manual 8, Drive Axle Housings. To obtain this publication, refer to the Service Notes page on the front inside cover of this manual.

⚠ WARNING

Do not repair weld on ductile cast iron housings. Repair welding can weaken the structural integrity of a component; in particular, heat-treated parts. Serious personal injury and damage to components can result.

Do Not Bend or Straighten a Damaged Drive Axle Housing

⚠ WARNING

Replace damaged or out-of-specification axle components. Do not bend, repair or recondition axle components by welding or heat-treating. A bent axle beam reduces axle strength, affects vehicle operation and voids Meritor's warranty. Serious personal injury and damage to components can result.

Always replace a damaged drive axle housing. Do not bend or straighten a damaged housing, which can misalign or weaken it, and void Meritor's warranty.

5 Assembly and Installation

Hazard Alert Messages

Read and observe all Warning and Caution hazard alert messages in this publication. They provide information that can help prevent serious personal injury, damage to components, or both.

⚠ WARNING

To prevent serious eye injury, always wear safe eye protection when you perform vehicle maintenance or service.

Park the vehicle on a level surface. Block the wheels to prevent the vehicle from moving. Support the vehicle with safety stands. Do not work under a vehicle supported only by jacks. Jacks can slip and fall over. Serious personal injury and damage to components can result.

Installation

Differential Carrier into the Axle Housing

⚠ WARNING

Solvent cleaners can be flammable, poisonous and cause burns. Examples of solvent cleaners are carbon tetrachloride, and emulsion-type and petroleum-base cleaners. Read the manufacturer's instructions before using a solvent cleaner, then carefully follow the instructions. Also follow the procedures below.

- **Wear safe eye protection.**
- **Wear clothing that protects your skin.**
- **Work in a well-ventilated area.**
- **Do not use gasoline, or solvents that contain gasoline. Gasoline can explode.**
- **You must use hot solution tanks or alkaline solutions correctly. Read the manufacturer's instructions before using hot solution tanks and alkaline solutions. Then carefully follow the instructions.**

1. Park the vehicle on a level surface. Block the wheels to prevent the vehicle from moving. Support the vehicle with safety stands. Do not work under a vehicle supported only by jacks. Jacks can slip and fall over. Serious personal injury and damage to components can result.
2. Inspect the inside of the axle housing and the carrier mounting surface. Use a cleaning solvent to remove dirt. Use compressed air to dry the cleaned areas.
3. Inspect the axle housing for damage. If necessary, repair or replace the axle housing.
4. Check for loose studs, if used, in the housing mounting surface. Remove and clean loose studs.
5. Apply liquid adhesive to threaded holes. Install the studs into the axle housing. Tighten to specification. Refer to Section 7.
6. If used, install the parking brake onto the differential carrier. Refer to the procedure in this section.

POSE™ Seal

1. Apply the lubricant used in the axle housing to the yoke or the flange hub.
2. Verify that the lips of the POSE™ seal, and the outer retainer of the triple-lip seal or the main seal, are clean and free from dirt and particles that may contribute to oil leakage between the seals.

NOTE: The POSE™ seal will position itself correctly as the yoke or the flange is pressed onto the shaft.

3. Install the POSE™ seal onto the yoke or the flange hub by hand. The lips of the seal must face toward the end of the hub, opposite the shoulder. Slide the POSE™ seal onto the hub until the lips are 0.25-0.50-inch (6.4-12.7 mm) from the end of the hub. Do not install the POSE™ seal against the shoulder. Figure 5.1.

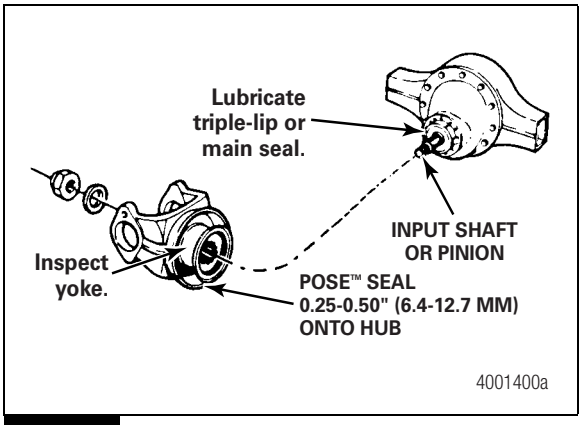


Figure 5.1

NOTE: After you install the POSE™ seal onto the yoke hub, immediately install the yoke and seal assembly to the pinion shaft. If you do not immediately install the yoke and POSE™ seal to the pinion shaft, the self-positioning capabilities of the seal could be hindered and contamination or damage to the POSE™ seal system may occur. The yoke must be completely seated before you tighten the pinion nut to the input shaft.

4. Before you install the yoke or the flange onto the input shaft or the pinion, apply the lubricant used in the axle housing to the hub area where the POSE™ seal has wiped off the lubricant.
5. Install the yoke or the flange.

Yoke

NOTE: A yoke installation tool, D80T-4859-B, is available from OTC Tool and Equipment Division. To obtain this tool, refer to the Service Notes page on the front inside cover of this manual.

1. Use the yoke installation tool, D80T-4859-B or equivalent, to install the yoke.
2. Install the washer and the nut that secure the yoke to the drive pinion. Use a holding tool and tighten the nut. Refer to Section 8.
3. Apply silicone gasket material to the carrier mounting surface on the housing. Refer to Section 4.

⚠ CAUTION

Do not use a hammer or a mallet to install the carrier. A hammer or a mallet will damage the carrier mounting flange and cause leaks.

4. Use a hydraulic roller jack or a lifting tool to install the carrier into the axle housing.
5. Install the nuts or capscrews and washers into the four corner locations around the carrier and the axle housing. Hand-tighten the fasteners. Figure 5.2.

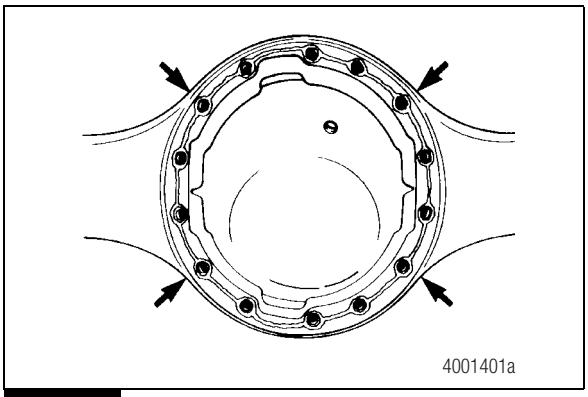


Figure 5.2

6. Carefully push the carrier into position. Tighten the four fasteners two or three turns each in a crisscross pattern. Figure 5.2.
7. Repeat Step 6 until the four fasteners are tightened to the correct torque value. Refer to Section 8.
8. Install the remaining fasteners and washers that hold the carrier in the axle housing. Tighten the fasteners to the correct torque value. Refer to Section 8.
9. Connect the drive shaft to the yoke.
10. For grease-lubricated wheel ends, install a new grease seal onto the hub studs and the housing spindle.
11. Install the gaskets and the axle shafts into the axle housing and the carrier. The gasket and the axle shaft flange must fit flat against the wheel hub.
12. Install the tapered dowels at each stud and into the axle shaft flange. Use a punch or a drift and hammer if necessary. Figure 5.3.

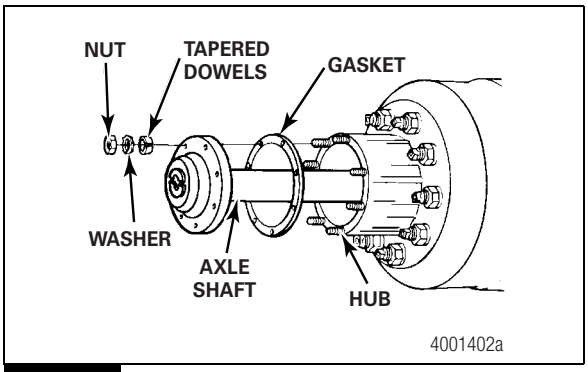


Figure 5.3

13. Install the nuts and the washers onto the studs. Tighten the nuts to the correct torque value. Refer to Section 8.
14. Connect the air lines and the electrical connectors.

⚠ WARNING

Before you service a spring chamber, carefully follow the manufacturer's instructions to compress and lock the spring to completely release the brake. Verify that no air pressure remains in the service chamber before you proceed. Sudden release of compressed air can cause serious personal injury and damage to components.

15. Release the spring in the air chamber. Refer to the manufacturer's instructions.

Assembly

⚠ WARNING

Use a brass or synthetic mallet for assembly and disassembly procedures. Do not hit steel parts with a steel hammer. Pieces of a part can break off. Serious personal injury and damage to components can result.

Observe all warnings and cautions provided by the press manufacturer to avoid damage to components and serious personal injury.

Hub with W-Series Brakes Without ABS: 59000, 61000, 71000 and RC-26-700 Series

1. If the wheel studs were removed from the hub, place the hub into a press with the drum side on top. Align the grooves on the studs with the grooves in the stud holes in the hub. Press the studs into position. If a press is not available, use a brass hammer.

⚠ CAUTION

Replacing wheel studs can affect the fit of the drum onto the hub. If new wheel studs have been installed in the hub, there may be some localized swelling on the hub flange. When there is swelling on the hub flange, use a hand grinder to remove a small amount of material over each stud. Do not remove material from the flange area between the studs, which will weaken the drum mounting area. Damage to components can result.

2. Use a ring gauge measuring 12.7510-12.7520-inches (323.875-323.900 mm) to check the flange diameter.
   - **If the ring gauge fits over the flange:** Proceed to Step 3.
   - **If the ring gauge does not fit over the hub flange because of swelling:** Use one of the following methods to remove the swelling on the hub flange. Remove only enough material to allow for an easy ring gauge or drum fit. Do not remove material from the flange area between the studs, which will weaken the drum mounting area.

   A. Use a hand grinder to remove a small amount of material over each stud. Check the ring gauge or drum fit frequently to ensure that you're not removing too much material.

   B. Use a lathe to machine the hub flange and remove any swells. Locate the lathe on the bearing cups. Check the ring gauge or drum fit frequently to ensure that you're not removing too much material.
3. Install the oil deflector. Install the nuts. Tighten the nuts to 175-250 lb-ft (237-339 N•m). T
4. Use a press and a sleeve to install the inner and the outer bearing cups into the hub.
5. Use a suitable driver to install a new oil seal into the oil seal retainer. The seal must be flush with the top of the retainer.
   - **If the seals are higher than the seal retainer bore length:** Use a suitable driver to install the seals until the seal seats in the retainer.

NOTE: Meritor specification O-617-B grease is thinner than O-617-A grease and permits easier packing of the wheel bearings.

6. For optional grease-lubricated wheel ends, pack the areas of the hub between the two bearings with Meritor specification O-617-A or O-617-B grease up to the smallest diameter of the bearing cups. Figure 5.4.

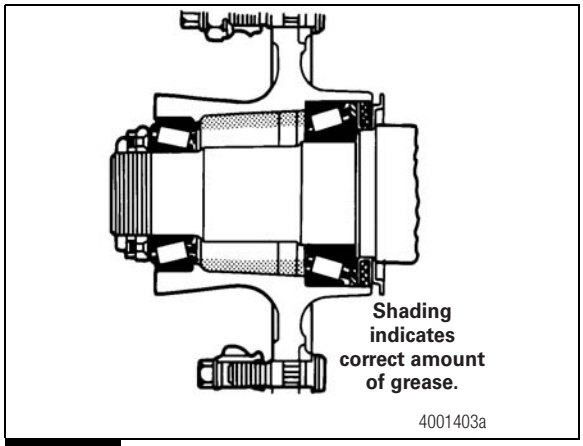


Figure 5.4

7. Pack the inner bearing cone with Meritor specification O-617-A or O-617-B grease.
8. Install the inner wheel bearing cone into the hub. Install the seal retainer into the hub. Tighten the retainer capscrews to 20-30 lb-ft (27-41 N•m).
9. Use a suitable driver to install the seal wiper onto the housing.
10. For optional grease-lubricated wheel ends, use a suitable driver to install the grease seal sleeve onto the end of the spindle.

Brake to the Housing Without ABS: 59000 and 61000 Series

1. Install the brake spider onto the housing.
2. Install the bolts and the nuts that secure the spider to the housing. Use a hardened washer under the head of the bolt and under the nut. Tighten the nuts to the correct torque. Refer to Section 8.
3. If the rivets were removed, replace them with bolts, washers and locknuts.
   - **For stamped steel housings:** Use 5/8"-18 Grade 8 bolts, hardened washers and Grade 8 locknuts.
   - **For cast housings:** Use M16x2 Grade 10.9 bolts, hardened washers and Grade 10.9 locknuts.
4. Reassemble the brake. Refer to Maintenance Manual 23B, Bus and Coach Brakes. To obtain this publication, refer to the Service Notes page on the front inside cover of this manual.

Hub to the Axle Without ABS: 59000, 61000, 71000 and RC-26-700 Series

1. Install the hub assembly onto the spindle. Do not damage the oil seal when you install the hub. Press the hub until the inner bearing is flat against the face of the spindle.

NOTE: Meritor specification O-617-B grease is thinner than O-617-A grease and permits easier packing of the wheel bearing.

2. For optional grease-lubricated wheel ends, pack the outer bearing cone with Meritor specification O-617-A or O-617-B grease.
3. Install the outer bearing cone onto the spindle and push it into its cup inside the hub.
4. Adjust the wheel bearings. Refer to the procedure in this section.
5. Install the brake drum.
6. Use wheel nuts and spacers, if required, to ensure that the brake drum is in contact with the hub.
7. Attach the magnetic base of a dial indicator to the housing. Measure brake drum total indicator runout (TIR) approximately one-inch (25 mm) from the open end of the drum. The runout should not exceed 0.015-inch (0.381 mm).
   - **If runout exceeds specifications:** Remove the drum from the hub. Rotate the drum and install it. Verify that runout does not exceed 0.015-inch (0.381 mm).
   - **If you are unable to rotate the drum to provide the correct runout:** Remove and turn the drum. The maximum diameter should be at least 0.1-inch (2.5 mm) less than the maximum dimension marked on the outer edge of the drum to maintain correct drum wear allowance. Verify that runout does not exceed 0.015-inch (0.381 mm).
   - **If turning the drum does not provide the correct runout:** Replace the drum.

Hub with W-Series Brakes with ABS: 59000, 61000, 71000 and RC-26-700 Series

1. If the wheel studs were removed from the hub, place the hub into a press with the drum side on top. If a press is not available, use a brass hammer. Align the grooves on the studs with the grooves in the stud holes in the hub. Press the studs into position.

⚠ CAUTION

Replacing wheel studs can affect the fit of the drum onto the hub. If new wheel studs have been installed in the hub, there may be some localized swelling on the hub flange. When there is swelling on the hub flange, use a hand grinder to remove a small amount of material over each stud. Do not remove material from the flange area between the studs, which will weaken the drum mounting area. Damage to components can result.

2. Use a ring gauge measuring 12.7510-12.7520-inches (323.875-323.900 mm) to check the flange diameter.
   - **If the ring gauge fits over the flange:** Proceed to Step 3.
   - **If the ring gauge does not fit over the hub flange because of swelling:** Use one of the following methods to remove the swelling on the hub flange. Remove only enough material to allow for an easy ring gauge or drum fit. Do not remove material from the flange area between the studs, which will weaken the drum mounting area.
     A. Use a hand grinder to remove a small amount of material over each stud. Check the ring gauge or drum fit frequently to ensure that you're not removing too much material.
     B. Use a lathe to machine the hub flange and remove any swells. Locate the lathe on the bearing cups. Check the ring gauge or drum fit frequently to ensure that you're not removing too much material.
3. Install the oil deflector. Install the nuts. Tighten the nuts to 175-250 lb-ft (237-339 N•m).
4. Use a press and a sleeve to install the inner and the outer bearing cups into the hub.
5. For optional grease-lubricated wheel ends, pack the area of the hub between the two bearings with Meritor specification O-617-A or O-617-B grease up to the smallest diameter of the bearing cups.
6. Use a suitable driver to install a new oil seal into the oil seal retainer. The seal must be flush with the top of the retainer.
   - **If the seals are higher than the seal retainer bore length:** Use a suitable driver to install the seals until the seal seats in the retainer.

NOTE: Meritor specification O-617-B grease is thinner than O-617-A grease and permits easier packing of the wheel bearings.

7. Pack the inner bearing cone with Meritor specification O-617-A or O-617-B grease. Figure 5.5.

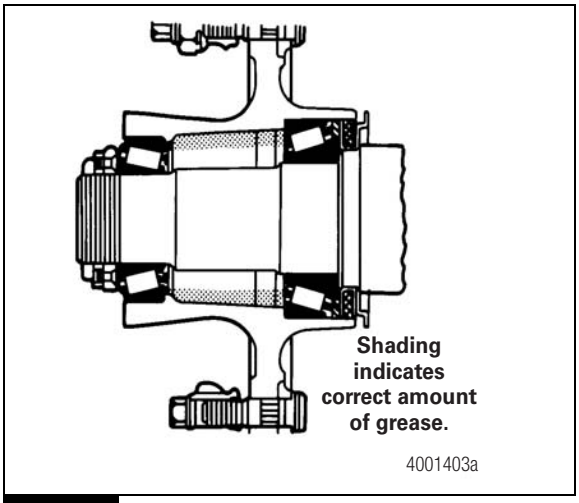


Figure 5.5

8. Install the inner wheel bearing cone into the hub. Install the seal retainer and the ABS tooth wheel onto the hub. Tighten the retaining capscrews to 20-30 lb-ft (27-41 N•m).
9. Use a suitable driver to install the seal wiper onto the housing.
10. For optional grease-lubricated wheel ends, use a suitable driver to install the grease seal sleeve onto the end of the spindle.
11. Use wheel nuts and spacers, if required, to ensure that the brake drum contacts the hub.

12. Attach the magnetic base of a dial indicator to the housing. Measure brake drum total indicator runout (TIR) approximately one-inch (25 mm) from the open end of the drum. The runout should not exceed 0.015-inch (0.381 mm).
    - **If runout exceeds specifications:** Remove the drum from the hub. Rotate the drum and install it. Verify that runout does not exceed 0.015-inch (0.381 mm).
    - **If you are unable to rotate the drum to provide the correct runout:** Remove and turn the drum. The maximum diameter should be at least 0.1-inch (2.5 mm) less than the maximum dimension marked on the outer edge of the drum to maintain correct drum wear allowance. Verify that runout does not exceed 0.015-inch (0.381 mm).
    - **If turning the drum does not provide the correct runout:** Replace the drum.

Hub with Drum Brakes: RC-23-160 Series

1. If the wheel studs were removed from the hub, place the hub into a press with the wheel mounting surface pointing down. If a press is not available, use a brass hammer.
2. Align the serrations on the stud with the serration marks in the hub, if the hub was previously used. Press the stud into the hub.
3. Use a press and a sleeve to install the inner and the outer bearing cups into the hub.
4. Use a suitable driver to install the ABS tooth wheel onto the hub. Do not damage the tooth wheel.

NOTE: Meritor specification O-617-B grease is thinner than O-617-A grease and permits easier packing of the wheel bearings.

5. Pack the inner bearing cone with Meritor specification O-617-A or O-617-B grease.
6. Install the inner wheel bearing cone into the hub.
7. Use a suitable driver to install a new seal into the hub until the seal is seated in the hub.

Brake to the Housing with ABS: 59000, 61000, 71000 and RC-26-700 Series

1. Install the brake spider onto the housing.
2. Assemble the ABS spring clip and the ABS sensor into the ABS support bracket. Figure 5.6.

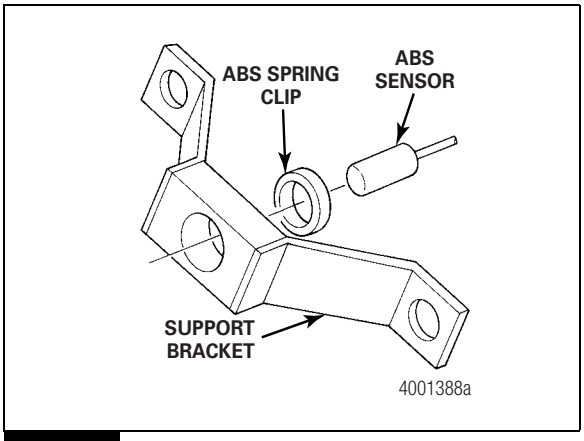


Figure 5.6

3. Route the connector end of the ABS sensor through the exit hole in the brake spider and the housing brake flange. Figure 5.7.

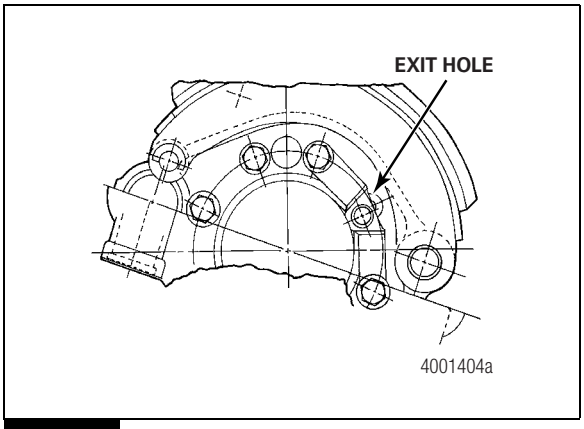


Figure 5.7

4. With the ABS sensor block in contact with the housing, use the bolts, washers and nuts to secure the support bracket assembly to the brake spider. Use washers under the bolt heads and under the nuts. Tighten the nuts to hold the bracket in position. Figure 5.8.

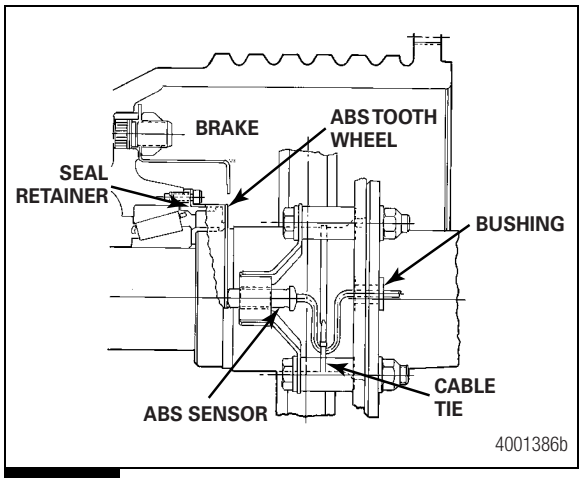


Figure 5.8

5. For cast housings, use M6x1 socket-head capscrews to secure the ABS sensor block to the housing. Tighten the capscrews to 8-12 lb-ft (11-16 N•m). Figure 5.9.

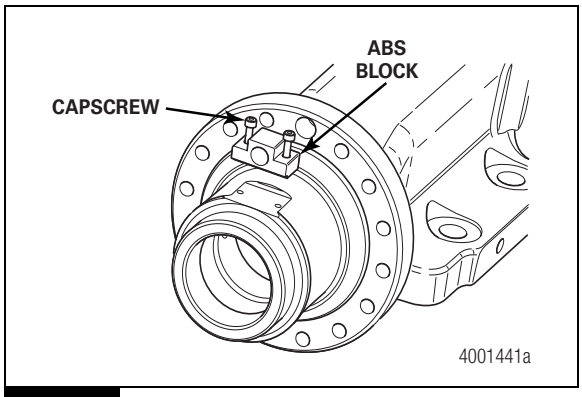


Figure 5.9

6. Tighten all other spider attachment fasteners to the correct torque. Refer to Section 8.
7. If required, install the hose clamp that secures the ABS sensor to the housing. The ABS sensor mounting block must contact the housing.
8. If the rivets have been removed, replace them with bolts, washers and locknuts.
   - **For stamped steel housings:** Use 5/8"-18 Grade 8 bolts, hardened washers and Grade 8 locknuts.
   - **For cast housings:** Use M16x2 Grade 10.9 bolts, hardened washers and Grade 10.9 locknuts.

Hub to the Axle with ABS: 59000, 61000, 71000 and RC-26-700 Series

1. Install the hub assembly onto the spindle. Do not damage the oil seal when you install the hub assembly. Press the hub until the inner bearing is flat against the face of the spindle.

NOTE: Meritor specification O-617-B grease is thinner than O-617-A grease and permits easier packing of the wheel bearing.

2. For optional grease-lubricated wheel ends, pack the outer bearing cone with Meritor specification O-617-A or O-617-B grease.
3. Install the outer bearing cone onto the spindle and push it into its cup inside the hub.
4. Adjust the wheel bearings. Refer to the procedure in this section.
5. For stamped steel housings, verify that the ABS sensor and the ABS tooth wheel on the hub are aligned and the ABS sensor block contacts the housing. Tighten the two bracket mounting bolts to 180-230 lb-ft (244-312 N•m).
6. For cast housings, use M6x1 socket-head capscrews to secure the ABS block to the housing. Tighten the capscrews to 8-12 lb-ft (11-16 N•m).
7. Push the ABS sensor toward the tooth wheel until contact is made.
8. Rotate the hub. Check the relationship of the ABS sensor and the tooth wheel. A 0.020-inch (0.5 mm) maximum gap is allowed between the sensor and the tooth wheel.
9. Fasten the sensor wire to the housing with a cable tie. Install the bushing onto the ABS cable at the exit hole.

10. Complete the brake assembly. Refer to Maintenance Manual 23B, Bus and Coach Brakes. For ABS braking systems, refer to Maintenance Manual 28, ABS for Trucks, Tractors and Buses (C Version ECUs) and Maintenance Manual 30, ABS for Trucks, Tractors and Buses (D Version ECUs). To obtain these publications, refer to the Service Notes page on the front inside cover of this manual.

Brake to the Housing with Drum Brakes: RC-23-160 Series

1. Install the brake spider onto the housing.
2. Install the bolts and the nuts that secure the spider or the torque plate to the housing. Use a hardened washer under the bolt head and under the nut. Tighten to the correct torque. Refer to Section 8.
3. Assemble the brake. Refer to Maintenance Manual 23B, Bus and Coach Brakes. To obtain this publication, refer to the Service Notes page on the front inside cover of this manual.
4. Install the ABS sensor spring clip into the upper ABS mounting block in the direction of the arrow on the block.
5. Install the ABS sensor fully into the spring clip.
6. Route the ABS sensor cable through the hole in the brake flange.

Hub to the Axle with Drum Brakes: RC-23-160 Series

1. Install the hub assembly onto the spindle. Do not damage the oil seal when you install the hub assembly. Press the hub until the inner bearing is flat against the face of the spindle.
2. Install the outer bearing cone onto the spindle. Push it into its cup inside the hub.
3. Adjust the wheel bearings. Refer to the procedure in this section.
4. Push the ABS sensor toward the tooth wheel on the hub until the sensor contacts the tooth wheel.
5. Rotate the hub. Check the relationship of the ABS sensor and the tooth wheel. A 0.020-inch (0.5 mm) maximum gap is allowed between the ABS sensor and the tooth wheel. For ABS braking systems, refer to Maintenance Manual 28, ABS for Trucks, Tractors and Buses (C Version ECUs) and Maintenance Manual 30, ABS for Trucks, Tractors and Buses (D Version ECUs). To obtain these publications, refer to the Service Notes page on the front inside cover of this manual.
6. Install the brake drum. Use wheel nuts and spacers, if required, to ensure that the brake drum contacts the hub.
7. Attach the magnetic base of a dial indicator to the housing. Measure brake drum total indicator runout (TIR) approximately one-inch (25 mm) from the open end of the drum. The runout should not exceed 0.015-inch (0.381 mm).
   - **If runout exceeds specifications:** Remove the drum from the hub. Rotate the drum and install it. Verify that runout does not exceed 0.015-inch (0.381 mm).
   - **If you are unable to rotate the drum to provide the correct runout:** Remove and turn the drum. The maximum diameter should be at least 0.1-inch (2.5 mm) less than the maximum dimension marked on the outer edge of the drum to maintain correct drum wear allowance. Verify that runout does not exceed 0.015-inch (0.381 mm).
   - **If turning the drum does not provide the correct runout:** Replace the drum.

Hub with Disc Brakes: RC-23-160 Series

1. If the wheel studs were removed from the hub, place the hub into a press with the wheel mounting surface facing down. If a press is not available, use a brass hammer.
2. If the hub was previously used, align the serrations on the stud with the serration marks in the hub. Press the stud into the hub.
3. Use a press and a sleeve to install the inner and the outer bearing cups into the hub.

NOTE: Meritor specification O-617-B is thinner than O-617-A grease and permits easier packing of the wheel bearings.

4. Pack the inner bearing cone with Meritor specification O-617-A or O-617-B grease.
5. Install the inner wheel bearing cone into the hub.
6. Use a suitable driver to install a new seal into the hub until the seal is seated in the hub.
7. If the ABS tooth wheel was removed from the rotor, install the tooth wheel. Tighten the 1/4"-20 capscrews to 105-135 lb-in (12-15 N•m).
8. If the rotor was removed from the hub, install the rotor. Tighten the 5/8"-18 socket-head capscrews to 180-230 lb-ft (244-312 N•m).

5 Assembly and Installation

Brake to the Housing with Disc Brakes: RC-23-160 Series

1. If the ABS sensor bushing was removed from the torque plate, use a suitable driver to install the bushing. The bushing must extend beyond the torque plate 0.977-1.007-inches (24.82-25.58 mm). Figure 5.10.

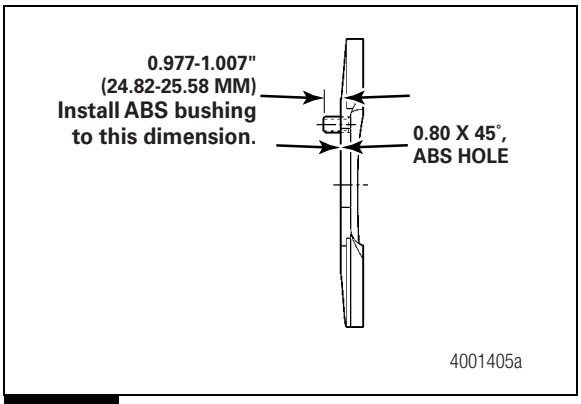


Figure 5.10

2. Install the torque plates onto the housing.
3. Install the bolts and the nuts that secure the torque plate to the housing. Use a hardened washer under the bolt head and under the nut. Tighten the nut to the correct torque. Refer to Section 8.
4. Install the ABS sensor spring clip into the sensor bushing in the torque plate. Install the clip through the brake flange in the housing.
5. Install the ABS sensor fully into the spring clip.

Hub to the Axle with Disc Brakes: RC-23-160 Series

1. Install the hub assembly onto the spindle. Do not damage the oil seal when you install the hub assembly. Press the hub until the inner bearing is flat against the face of the spindle.
2. Install the outer bearing cone onto the spindle. Push the cone into its cup inside the hub.
3. Adjust the wheel bearings. Refer to the procedure in this section.
4. Push the ABS sensor toward the tooth wheel on the rotor until the sensor contacts the tooth wheel.
5. Rotate the hub. Check the relationship of the ABS sensor and the tooth wheel. A 0.020-inch (0.5 mm) maximum gap is allowed between the ABS sensor and the tooth wheel. Refer to Maintenance Manual 28, ABS for Trucks, Tractors and Buses (C Version ECUs) and Maintenance Manual 30, ABS for Trucks, Tractors and Buses (D Version ECUs) for ABS braking systems. To obtain these publications, refer to the Service Notes page on the front inside cover of this manual.
6. Assemble the brake. Refer to the disc brake manufacturer's instructions.
7. Attach the magnetic base of a dial indicator to the housing. Measure the disc brake rotor inside surface runout. The runout should not exceed 0.015-inch (0.381 mm).
   - **If runout exceeds specifications:** Remove the rotor from the hub. Rotate the rotor and install it. Verify that runout does not exceed 0.015-inch (0.381 mm).
   - **If you are unable to rotate the rotor to provide the correct runout:** Remove and turn the rotor. The minimum dimension should be at least 1.626-inches (41.3 mm). You must turn both sides of the rotor to ensure that the braking surfaces are parallel to each other. Verify that runout does not exceed 0.015-inch (0.381 mm).
   - **If turning the rotor does not provide the correct runout:** Replace the rotor.

Drum to Hub with W-Series Brakes: 59000, 61000 and 71000

⚠ WARNING

You must carefully follow installation procedures when you install a brake drum onto a hub. An incorrect installation can cause the drum to fracture, which will affect braking performance. Loss of vehicle control, serious personal injury and damage to components can result.

NOTE: Replacing wheel studs can affect the fit of the drum onto the hub. If new wheel studs have been installed in the hub, there may be some localized swelling on the hub flange.

A Hub Mounted on the Axle

1. Use a wire brush to remove any rust, burrs and debris on both mating surfaces. Use a cloth dampened with water or a water-base solution to clean the brake drum pilot on both the brake drum and the hub flange.

2. Install the drum onto the hub. Carefully slide the drum onto the hub flange. Do not force the brake drum over the flange.
   - **If the brake drum does not install easily over the hub flange:** Refer to the hub assembly procedure in this section to adjust the fit of the drum on the flange.
3. Install the wheel nuts and suitable spacers to fasten the drum to the hub.
4. Attach the magnetic base of a dial indicator to the axle housing. Measure brake drum total indicator runout (TIR) approximately one-inch (25 mm) from the open end of the drum. The runout should not exceed 0.015-inch (0.381 mm).
   - **If runout exceeds specifications:** Remove the drum from the hub. Rotate the drum and install it. Verify that runout does not exceed 0.015-inch (0.381 mm).
   - **If you are unable to rotate the drum to provide the correct runout:** Remove and turn the drum. The maximum diameter should be at least 0.1-inch (2.5 mm) less than the maximum dimension marked on the outer edge of the drum to maintain correct drum wear allowance. Install the drum. Verify that runout does not exceed 0.015-inch (0.381 mm).
   - **If turning the drum does not provide correct runout:** Replace the drum.

A Hub Not Mounted on the Axle

1. Use a wire brush to remove any rust, burrs and debris on both mating surfaces. Use a cloth dampened with water or a water-base solution to clean the brake drum pilot on both the brake drum and the hub flange.
2. Assemble the hub, drum and wheel. Do not force the brake drum over the flange.
   - **If the brake drum does not install easily over the hub flange:** Refer to the hub assembly procedure in this section to adjust the fit of the drum on the flange.
3. Mount the hub, drum and wheel assembly onto a suitable spindle with the wheel bearings correctly adjusted.
4. Attach the magnetic base of a dial indicator to the spindle base. Measure brake drum total indicator runout (TIR) approximately one-inch (25 mm) from the open end of the drum. The runout should not exceed 0.015-inch (0.381 mm).
   - **If runout exceeds specifications:** Remove the drum from the hub. Rotate the drum and install it. Verify that runout does not exceed 0.015-inch (0.381 mm).
   - **If you are unable to rotate the drum to provide the correct runout:** Remove and turn the drum. The maximum diameter should be at least 0.1-inch (2.5 mm) less than the maximum dimension marked on the outer edge of the drum to maintain correct drum wear allowance. Install the drum. Verify that runout does not exceed 0.015-inch (0.381 mm).
   - **If turning the drum does not provide correct runout:** Replace the drum.
5. Mount the hub assembly onto the axle. Refer to the procedure in this section.

Adjustment

Wheel Bearings

⚠ WARNING

When you perform a wheel bearing adjustment, observe the following guidelines.

- **Always use the correct size wrench socket.**
- **Always use a torque wrench to tighten the adjusting nuts to their correct adjusting torque.**
- **Do not tighten or loosen the adjusting nuts by hitting the nuts with a hammer or by hitting a chisel or a drift placed against the nuts with a hammer. Damage to the nuts can result. Damaged adjusting nuts can prevent a correct wheel bearing adjustment, cause possible loss of vehicle wheel-end equipment and cause serious personal injury.**

1. Install the inner wheel bearing adjusting nut onto the spindle and against the outer bearing. Figure 5.11.

5 Assembly and Installation

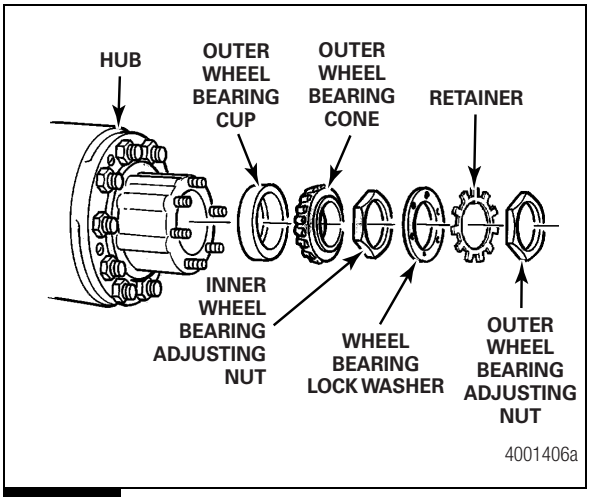


Figure 5.11

2. Tighten the adjusting nut to 100 lb-ft (136 N•m) while rotating the hub a minimum of eight revolutions to fully seat the wheel bearings.
3. Loosen the inner adjusting nut one full turn.
4. Retighten to 50 lb-ft (68 N•m).
5. Loosen the inner adjusting nut 1/3 turn.
6. Install the lock washer. If the hole in the washer is not aligned with the inner adjusting nut pin, remove the washer, turn the washer over and install it. The pin and the hole should now be aligned. If not, slightly adjust the inner adjusting nut. Use whichever lock washer causes the least movement of the adjusting nut. Figure 5.12.

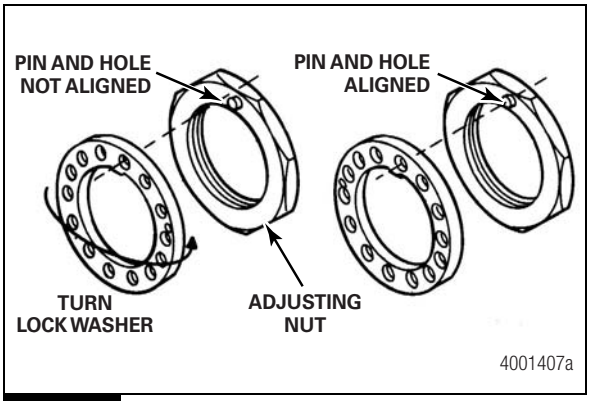


Figure 5.12

7. Assemble the stamped retainer and the outer wheel bearing adjusting nut onto the spindle.
8. Tighten the jam nut to 250-400 lb-ft (339-542 N•m). This should provide 0.001-0.010-inch (0.025-0.25 mm) of wheel end play. Readjust if necessary.
9. Use the following procedure to check end play.
   A. Attach the magnetic base of a dial indicator to the axle housing. Touch the dial indicator stem against the back of the hub flange.
   B. Slightly rotate the hub in both directions while pushing inward until the dial indicator does not change. Set the dial indicator to ZERO.
   C. Slightly rotate the hub in both directions while pulling OUTWARD until the dial indicator does not change.
10. The dial indicator reading is the end play.
    - **If end play does not meet specification:** Remove the outer wheel bearing adjusting nut, the stamped retainer and the lock washer. Tighten or loosen the inner adjusting nut as required to set the correct end play. Repeat Step 6 through Step 9.
11. When end play is correct, bend the two opposing tabs on the stamped retainer over the flats of the outer wheel bearing adjusting nut.
12. For optional grease-lubricated wheel ends, install a new grease seal onto the hub studs and the housing spindle. Refer to Section 3.
13. Install the axle shafts, gasket and tapered dowels at each stud.
14. Install the nuts and the washers onto the studs. Tighten the nuts to the correct torque value. Refer to Section 8.

Installation

Axle Tube: 59000 and 61000 Series

1. Install the two puller screws into the axle housing. Connect the puller screws with the connecting nut. Figure 5.13.

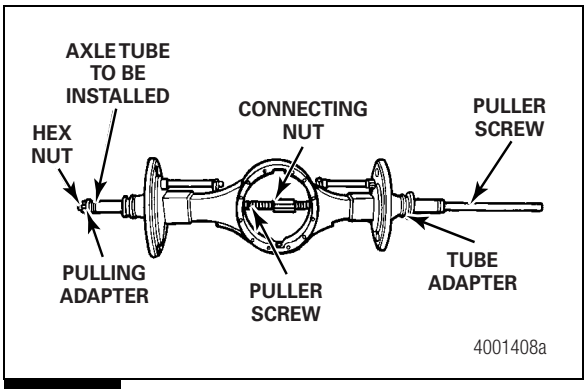


Figure 5.13

2. Install the pulling adapter into each end of the axle tube. Figure 5.13.
3. Install the axle tube and the adapters into the housing. Install the hex nut. Figure 5.13.
4. Position the tube adapter at the opposite end of the axle housing. Figure 5.13.
5. Install the puller tube onto the tube adapter. Figure 5.14.
6. Install the hydraulic ram onto the puller tube. Install the speed nut onto the puller screw. Tighten the nut to secure the ram and the tube to the axle housing. Figure 5.14.

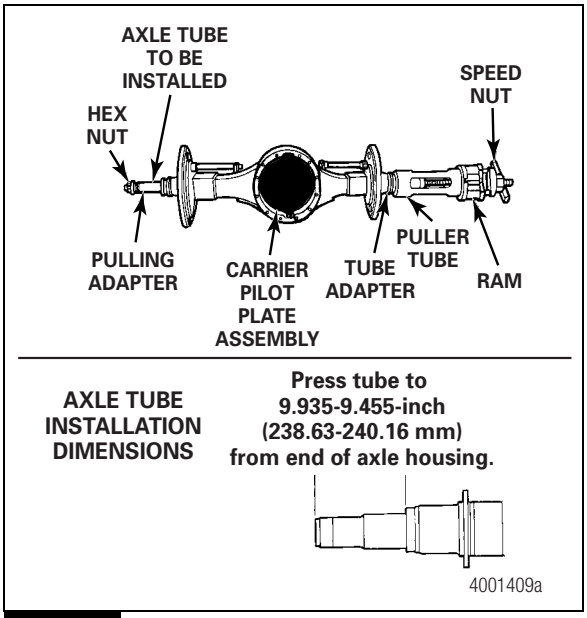


Figure 5.14

7. Install the carrier plate assembly to support the carrier ring during tube installation.
8. Connect the hydraulic ram to a hydraulic pump. Figure 5.14.
9. Apply pressure to install the axle tube into the housing. Press the axle tube into the housing until the end of the tube is 9.935-9.455-inches (238.63-240.16 mm) from the end of the axle housing. Figure 5.14.

⚠ WARNING

Take care when you use Loctite® adhesive to avoid serious personal injury. Read the manufacturer's instructions before using this product. Follow the instructions carefully to prevent irritation to the eyes and skin.

NOTE: The hole for the dowel must not go through the spindle. If the hole goes through the spindle, oil will leak out of the dowel hole and the housing will not pass a pressure test.

10. Install a dowel into the housing and the spindle. Figure 5.15.

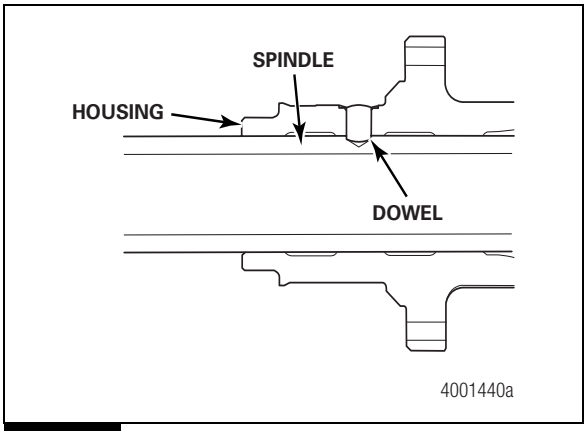


Figure 5.15

A. Drill a 0.79-inch (20 mm) diameter hole in the new spindle with a tolerance of +0.005-inch (0.130 mm) and –0.00004-inch (0.001 mm). The hole should be 1.2-1.3-inches (30.5-32.5 mm) deep. Measure the depth from the flat spotface on the housing to the tip of the drill bit. Align the hole with the hole in the housing.

B. Apply Loctite® 277 threadlocker to the surface of the dowel. Install the dowel into the housing and the spindle. Use a hammer to fully seat the dowel. The dowel should be approximately flush with the spotface on the housing.

11. Install the differential carrier. Refer to the procedure in this section.
12. Install the hub and drum assembly, axle shafts and tire and wheel assembly. Refer to the vehicle manufacturer's instructions.

Torque Rod Brackets: 61000 with Cast Housing and 71000 Series Axles

NOTE: An anti-seize lubricant may be used for easier dowel installation.

1. Use a hammer to install the dowel into the housing. The dowel must be fully seated in the hole.
2. Verify that the mounting surfaces on the housing and the bracket are clean and dry. If an anti-seize lubricant was used in Step 1, wipe any excess from the housing surface.
3. Use a hammer to install the bracket onto the dowel. The bracket must be fully seated against the housing.
4. Install the M20x2.5 capscrews and the hardened washers. Tighten the capscrews to 340-400 lb-ft (460-540 N•m).

Camshaft

1. If removed, install the bushings into the differential carrier and the bearing cage. Use a hammer and a driver tool to install the bushings.
2. Install a new oil seal into the bearing cage. The seal lip must be installed toward the bushing. Figure 5.16.

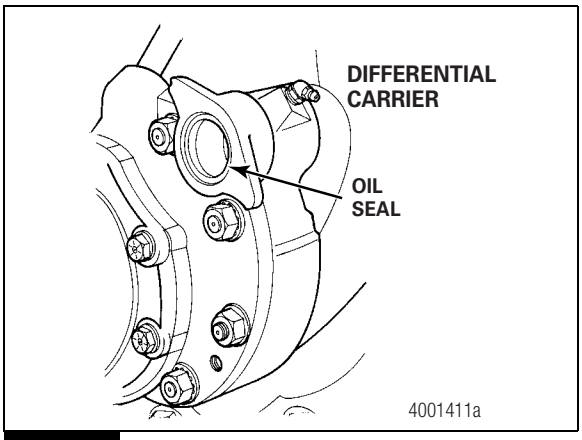


Figure 5.16

3. Lubricate the camshaft and the camshaft bushing. Refer to Section 7.
4. Install the splined end of the camshaft through the bearing cage and the differential carrier. Be careful not to damage the bushings and the oil seal when you install the camshaft. Figure 5.17.

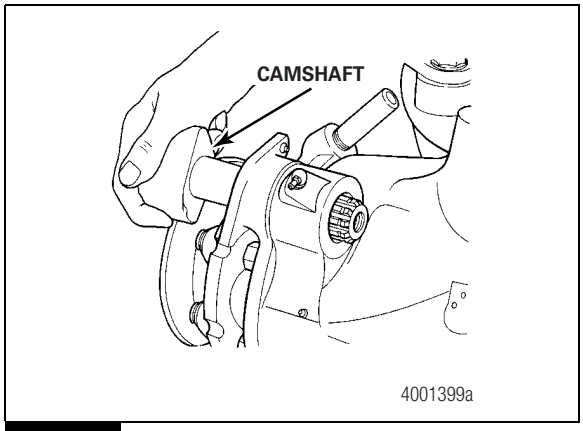


Figure 5.17

5. Install a washer onto the end of the camshaft.
6. Lubricate the camshaft splines with an anti-seize lubricant, Meritor specification O-637 or equivalent.
7. Install the adjusting lever onto the camshaft. Install the washers and the snap ring. Figure 5.18.

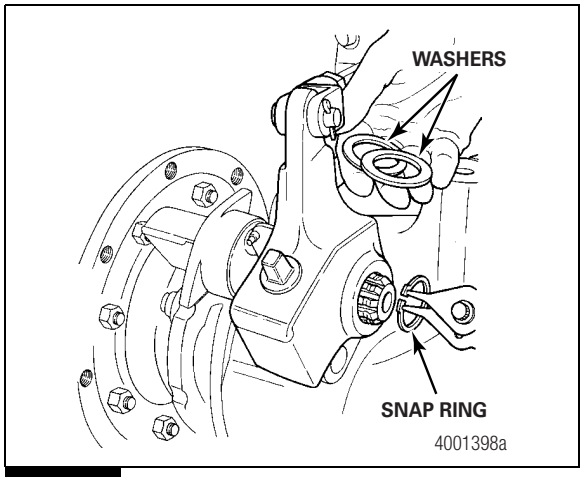


Figure 5.18

8. Connect the parking brake linkage to the adjusting lever.
9. Install the yoke. Refer to the procedure in this section.
10. Install the brake shoes. Refer to the procedure in this section.

T Series Parking Brake

Brake Shoes

1. Lubricate the anchor pins and the bushings. Refer to Section 7.
2. If removed, install the cam rollers into the shoe. Place the roller into the shoe. Install the shaft through the shoe and the roller. Align the set screw slot in the shaft with the hole in the shoe. Install and tighten the set screw. Figure 5.19.

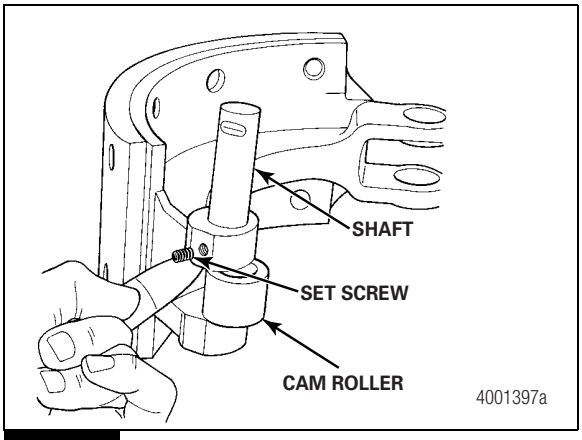


Figure 5.19

3. Place the brake shoes onto the bearing cage.
4. Install the anchor pins into the brake shoes. Verify that the flat side of the pin is installed toward the lock screw in the shoe. Figure 5.20.

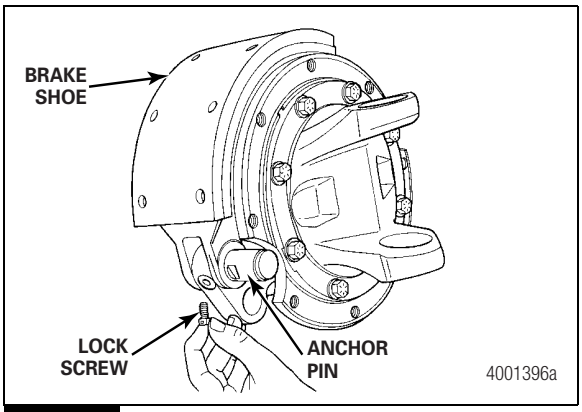


Figure 5.20

5. Use a hammer and a brass drift to install the anchor pins into the shoes. Figure 5.20.
6. Tighten the lock screws. Install the lock wire onto the anchor pin.
7. Install the oil seal and the oil seal retainers onto the anchor pins. Install the snap ring. Figure 5.21.

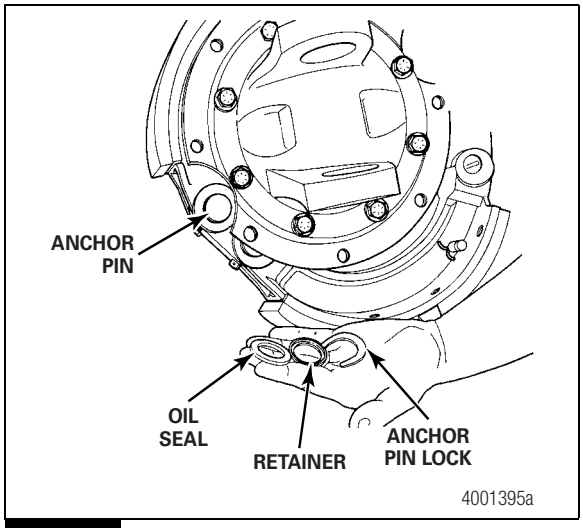


Figure 5.21

8. Place the brake shoes against the cam. Use brake spring pliers to install the return spring onto the shoes. Verify that the rollers in the brake shoes are against the low points of the cam. Figure 5.22.

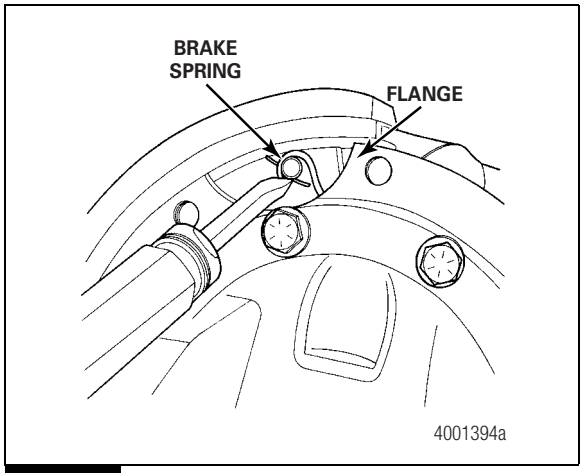


Figure 5.22

5 Assembly and Installation

9. Lubricate the cam and the rollers. Refer to Section 7.
10. Install the brake drum onto the yoke flange. Install the nuts and the washers. Tighten the nuts to 85-115 lb-ft (116-155 N•m). Figure 5.23.

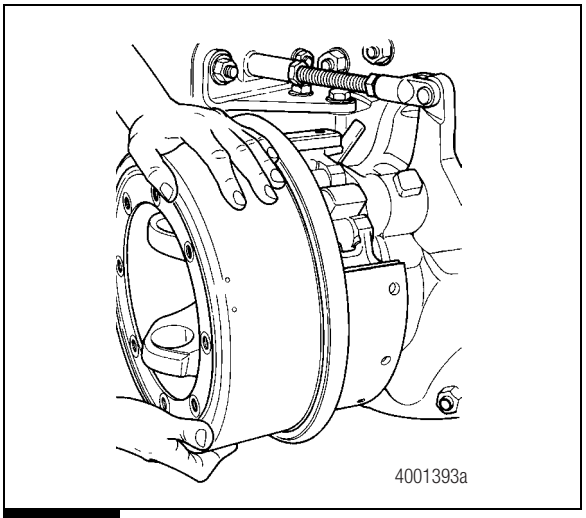


Figure 5.23

11. If removed, connect the drive shaft to the yoke.
12. Adjust the parking brake linkage and the lining-to-drum clearance. Refer to the procedures in this section.

Adjust the Lining-to-Drum Clearance

1. Park the vehicle on a level surface. Block the wheels to prevent the vehicle from moving.
2. Release the parking brake.
3. Remove all dirt from the adjusting lever and the back of the drum.
4. Use a feeler gauge to measure the clearance between the lining and the drum. Figure 5.24.

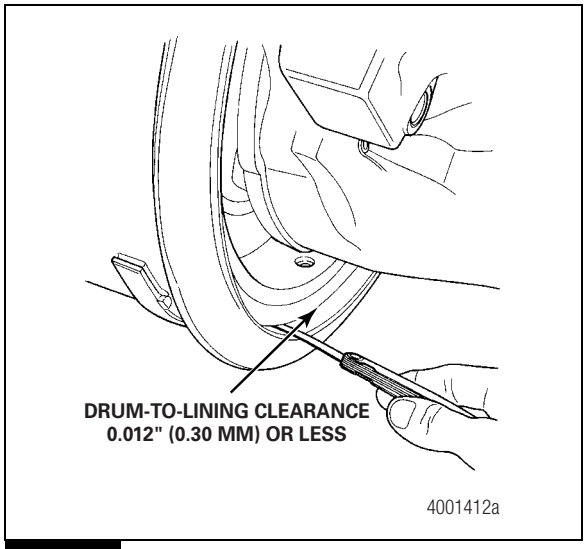


Figure 5.24

5. If the clearance is more than 0.012-inch (0.30 mm), turn the adjusting bolt adjusting lever until the clearance is correct. Figure 5.25.

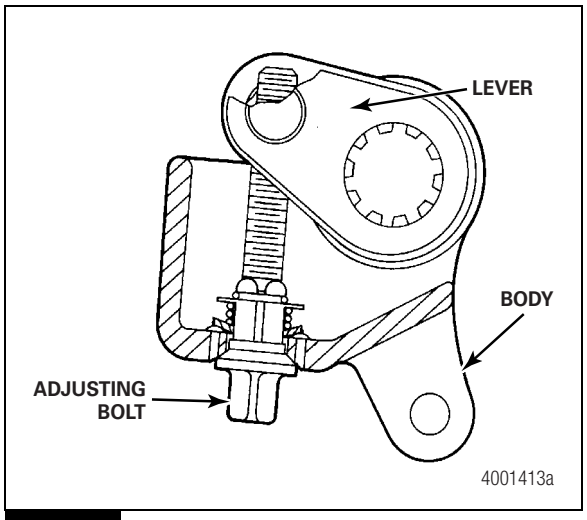


Figure 5.25

6. Operate the parking brake. Check for correct operation.

Adjust the Linkage

⚠ WARNING

Before you service a spring chamber, carefully follow the manufacturer's instructions to compress and lock the spring to completely release the brake. Verify that no air pressure remains in the service chamber before you proceed. Sudden release of compressed air can cause serious personal injury and damage to components.

1. Park the vehicle on a level surface. Block the wheels to prevent the vehicle from moving.
2. Release the brake system air pressure.
3. Tighten the spring chamber caging sleeve until the sleeve touches the non-pressure plate in the housing.
4. Remove and discard the cotter pin and the clevis pin. Disconnect the clevis from the slack adjuster. Loosen the clevis jam nut.
5. Rotate the push rod clevis until the center of the clevis pin hole is 10-inches (254 mm) from the chamber non-pressure plate. Tighten the jam nut. Figure 5.26.

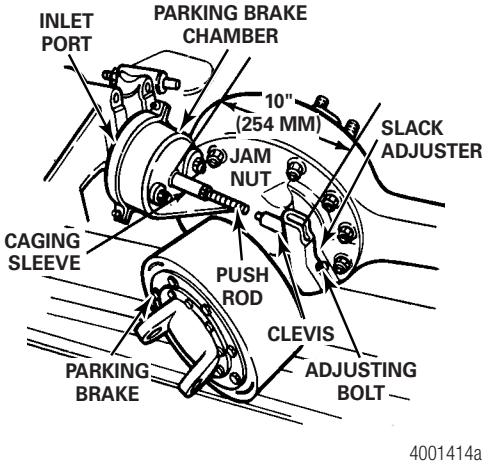


Figure 5.26

6. Apply the brake system air pressure.
7. Move the slack adjuster to connect the clevis. Install the clevis pin and a new cotter pin to fasten the clevis to the slack adjuster.
8. Adjust the lining-to-drum clearance. Refer to the procedure in this section.

Lubrication

Fill the Axle with Lubricant

NOTE: For additional lubrication information, refer to Maintenance Manual 1, Preventive Maintenance and Lubrication. To obtain this publication, refer to the Service Notes page on the front inside cover of this manual.

1. Park the vehicle on a level surface. Block the wheels to prevent the vehicle from moving. The axle lubricant capacity changes when the drive pinion angle changes.
2. Remove the fill plug from the side of the axle housing bowl cover.
3. Add the axle lubricant through the fill plug hole. Fill the axle with the lubricant until the lubricant level is even with the bottom of the fill plug hole. Refer to Section 8.
4. Install the fill plug. Tighten the plug to 35 lb-ft (47 N•m) minimum. When correctly installed, one complete thread of the fill plug is visible between the housing and the plug head.
5. Road test the vehicle in an unloaded condition for 1-2 miles (1.6-3.2 km) at speeds not more than 25 mph (40 km/h). Recheck the lubricant levels and all of the fasteners.

6 Diagnostics

Troubleshooting

⚠ WARNING

To prevent serious eye injury, always wear safe eye protection when you perform vehicle maintenance or service.

Table B: T Series Parking Brake

Condition	Possible Causes	Actions Required
Parking brake does not apply or there is not enough braking force.	The camshaft is worn or damaged.	Remove and replace the camshaft.
	The air chamber is not installed correctly.	Install the air chamber correctly.
	There is a leak or restriction in the air lines.	Repair the air lines.
	The air chamber air diaphragm is damaged.	Repair or replace the air chamber.
	The parking brake is not adjusted correctly.	Adjust the parking brake.
	There is grease or other contamination on the brake linings.	Replace the brake linings.
	The linings are worn, damaged or missing.	Replace the brake linings.
Parking brake does not release when air pressure is released.	The air chamber power spring is not fully released (spring is caged).	Release the power spring in the air chamber and uncage the spring.
	The air pressure that holds the springs in a compressed position is not fully released.	Repair the air system.
	The parking brake is not adjusted correctly.	Adjust the parking brake.
	The power springs in the air chamber are weak or broken.	Replace the air chamber.
	There is grease or other contamination on the brake linings.	Replace the brake linings.
Parking brake is dragging.	There is not enough air pressure to hold the spring.	Repair the air system.
	The air lines are connected to the wrong ports.	Connect lines to the correct ports.
	There are leaks in the air lines.	Repair or replace the air lines.
	There are leaks in the spring brake assembly.	Repair or replace the spring brake.
	The drum has too much runout.	Repair or replace the drums.
	The shoe return spring is weak, damaged or missing.	Replace the shoe return spring.
	The camshaft is damaged.	Remove and replace the camshaft.
	The rollers are damaged.	Remove and replace the rollers.

Hazard Alert Messages

Read and observe all Warning and Caution hazard alert messages in this publication. They provide information that can help prevent serious personal injury, damage to components, or both.

⚠ WARNING

To prevent serious eye injury, always wear safe eye protection when you perform vehicle maintenance or service.

During lubrication procedures, if grease flows from the seal near the camshaft head, replace the seal. Remove all grease or oil from the camshaft head, rollers and brake linings. Always replace linings contaminated with grease or oil, which can increase stopping distances. Serious personal injury and damage to components can result.

Lubrication

Camshaft Bushings

Specification

Multi-purpose chassis grease, 6% 12-hydroxy lithium stearate grease, NLGI Grade 1, Meritor specification O-617-A or equivalent

Multi-purpose chassis grease, 8% 12-hydroxy lithium stearate grease, NLGI Grade 2, Meritor specification O-617-B or equivalent

Schedule

Lubricate the camshaft bushings every 50,000 miles (80 000 km) or when necessary.

Procedure

Lubricate the camshaft bushings through the fittings in the differential carrier and the fitting in the drive pinion bearing cage. Figure 7.1.

Camshaft Splines

Specification

Metallic-base, temperature resistant anti-seize compound, Meritor specification O-637 or equivalent

Schedule

Lubricate the camshaft splines when necessary or when the brake is disassembled.

Procedure

Apply the lubricant to the camshaft splines. Figure 7.1.

Anchor Pins

Specification

Anchor pin grease, non-melting grease with Bentone thickeners, NLGI Grade 2, Meritor specification O-616 or equivalent

Schedule

Lubricate the anchor pins when necessary or when the brake is disassembled.

Procedure

Apply the lubricant to the anchor pins where the pins touch the brake shoes. Figure 7.1.

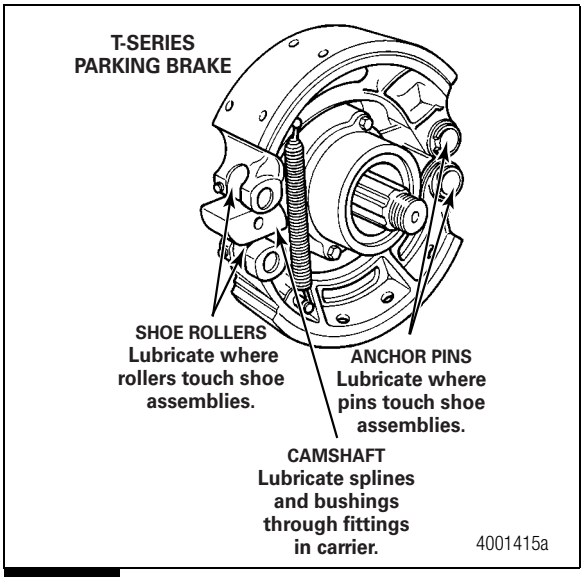


Figure 7.1

Shoe Rollers

Specification

Multi-purpose chassis grease, 6% 12-hydroxy lithium stearate grease, NLGI Grade 1, Meritor specification O-617-A or equivalent

Multi-purpose chassis grease, 8% 12-hydroxy lithium stearate grease, NLGI Grade 2, Meritor specification O-617-B or equivalent

Schedule

Lubricate the shoe rollers when necessary or when the brake is disassembled.

Procedure

Apply the lubricant to the roller pins where the pins touch the brake shoes. DO NOT put the lubricant on the part of the roller that touches the cam head. Figure 7.1.

7 Lubrication

Axle

Table C: Oil Specifications

	Gear Oil Type	A.P.I. Specification	SAE Grade	Meritor Specification	Military/SAE Specification	Outside Temperature
Non-Extended Drain Lubricants	Petroleum with EP Additives	GL-5	85W/140	0-76A	MIL-PRF-2105E and SAE J2360	Above +10°F (–12°C)
			80W/140	0-76B		Above –15°F (–26°C)
			80W/90	0-76D		Above –15°F (–26°C)
			75W/90	0-76E		Above –40°F (–40°C)
			75W	0-76J		From –40°F (–40°C) to 35°F (2°C)
			75W/140	0-76L		Above –40°F (–40°C)
Extended Drain Lubricants	Petroleum with Extended Drain Additives	GL-5	80W/90	—	MIL-PRF-2105E and SAE J2360	Above –15°F (–26°C)
	Semi-Synthetic		80W/90	—		Above –15°F (–26°C)
	Full Synthetic		75W/140	0-76M		Above –40°F (–40°C)
	Full Synthetic		75W/90	0-76N		Above –40°F (–40°C)

Table D: Lubricant Schedule

Type of Service	Check Oil Level	Oil Change Interval
Bus and Coach	Every 3,000 miles (4828 km)	Less than 60,000 miles (96 558 km) a year: Change two times per year
City Service		More than 60,000 miles (96 558 km) a year: Change every 25,000-30,000 miles (40 233-48 279 km)
Coach	Every 3,000 miles (4828 km)	Petroleum-based oil Initial drop at 1,000 miles (1609 km)
Highway Operation (Inter-city)		100,000 miles (160 930 km) or once per year, whichever is first
		Synthetic-based oil
		No initial drop required
		Change every 250,000 miles (402 325 km)

Table E: Lubricant Capacities

Axle Model	U.S. Pints *	Liters *
59722	30.5	14.4
59723	30.5	14.4
59732	30.5	14.4
59733	30.5	14.4
59752	30.5	14.4
59753	30.5	14.4
59842	30.5	14.4
59843	30.5	14.4
61042	41.0	19.4
61043	41.0	19.4
61052	41.0	19.4
61053	41.0	19.4
61063	44.0	20.8
61142	41.0	19.4
61143	41.0	19.4
61152	41.0	19.4
61153	41.0	19.4
61163	44.0	20.8
71063	44.0	20.8
71163	44.0	20.8
RC-23-160	41.0	19.4

* These quantities are approximate. Fill the housing with oil up to the bottom of the oil fill hole in the housing cover. If the wheel ends have been disassembled, oil must be provided to the wheel ends before the vehicle is placed back into service.

Fill Procedure for Axle Shafts and Hubs with Oil Fill Plugs

1. Rotate the hub until the fill plugs are at the top.
2. Remove the oil fill plugs. Fill each hub cavity with two pints (1 L) of rear axle lubricant.
3. Install and tighten the fill plugs to 10 lb-ft (13.8 N•m) minimum.

Axle Shafts and Hubs Without Oil Fill Plugs

1. Slowly drive each side of the vehicle over a six-inch (152.4 mm) raised surface so that the oil can flow out to the hubs.
2. Check the oil level in the housing and refill to the bottom of the fill plug.

7 Lubrication

T Series Parking Brake

Table F: Lubricant Specifications

Description	Lubricant Specification
Camshaft Bushings Shoe Rollers	Multi-purpose chassis grease, 6% 12-hydroxy lithium stearate grease, NLGI Grade 1, Meritor specification O-617-A, or equivalent
	Multi-purpose chassis grease, 8% 12-hydroxy lithium stearate grease, NLGI Grade 2, Meritor specification O-617-B, or equivalent
Anchor Pin	Anchor pin grease, non-melting grease with Bentone thickeners, Meritor specification O-616, or equivalent
Camshaft Splines	Metallic-base, temperature resistant anti-seize compound, Meritor specification O-637, or equivalent

Grease-Lubricated Wheel Ends

Table G: Lubricant Specifications

Description	Lubricant Specifications
Hub Cavity Bearing Cones	Multi-purpose chassis grease, 6% 12-hydroxy lithium stearate grease, NLGI Grade 1, Meritor specification O-617-A, or equivalent
	Multi-purpose chassis grease, 8% 12-hydroxy lithium stearate grease, NLGI Grade 2, Meritor specification O-617-B, or equivalent

Torque Specifications

Table H: 59000 Series Rear Axle and Parking Brake

		Torque Range	
Description	**Size**	**Lb-ft**	**N•m**
Axle Shaft-to-Flange Capscrew	0.312"-24	18-24	24-33
	0.50"-13	85-115	115-156
Axle Shaft-to-Flang Nut	0.438"-20	50-75	68-102
Plain Nut	0.50"-20	75-115	102-156
	0.312"-18	110-165	149-224
	0.625"-18	150-230	203-312
Axle Shaft-to-Flange Nut	0.438"-20	40-65	54-88
Locknut	0.50"-20	65-100	88-136
	0.562"-18	100-145	136-197
	0.625"-18	130-190	176-258
Breather Vent	0.375"-18	20 Min.	27 Min.
Drain Plug	0.75"-14	35 Min.	47 Min.
Carrier-to-Housing Nut	0.375"-16	35-50	48-68
	0.438"-14	60-75	81-102
	0.50"-13	85-115	115-156
	0.562"-12	130-165	176-224
	0.625"-11	180-230	244-312
Carrier-to-Housing Capscrew	0.50"-13	75-100	102-136
	0.50"-20	85-115	115-156
	0.625"-11	150-190	203-258
	0.625"-18	180-230	244-312
Cage-to-Carrier Nut	0.375"-16	30-50	41-68
	0.438"-14	50-75	68-102
	0.50"-13	75-115	102-156
	0.438"-12	110-165	149-224
	0.625"-11	150-230	203-312
Drum-to-Yoke Flange Nut	0.50"-20	85-115	115-156
Drive Pinion Nut	0.875"-20	200-275	271-373
	1.00"-20	300-400	407-542
	1.25"-12	700-900	949-1220
	1.25"-18	700-900	949-1220
	1.50"-12	800-1100	1085-1491
	1.50"-18	800-1100	1085-1491
	1.75"-12	900-1200	1220-1627
Brake Spider-to-Housing	0.625"-18	180-230	244-312
Wheel Stud-to-Hub	0.875"-14	175-250	237-339
Axle Shaft Oil Fill Plug		10 Min.	13.5 Min.

8 Specifications

Table I: 61000, 71000, RC-23-160 and RC-26-700 Series Rear Axle

		Torque Range	
Description	**Size**	**Lb-ft**	**N•m**
Axle Shaft-to-Flange Nut	0.438"-20	50-75	68-102
Plain Nut	0.50"-20	75-115	102-156
	0.312"-18	110-165	149-224
	0.625"-18	150-230	203-312
Axle Shaft-to-Flange Nut	0.438"-20	40-65	54-88
Locknut	0.50"-20	65-100	88-136
	0.312"-18	100-145	136-197
	0.625"-18	130-190	176-258
Hubcap Nuts	0.5625"-18	20-28	27-38
	0.625"-18	20-28	27-38
Breather Vent	0.375"-18	20 Min.	27 Min.
Drain Plug	0.75"-14	35 Min.	47 Min.
	M24x1.5	25 Min.	35 Min.
Carrier-to-Housing Nut	0.625"-11	180-230	244-312
Carrier-to-Housing Capscrew	0.625"-11	150-190	203-258
	0.625"-18	180-230	244-312
	M16x2	180-230	244-312
Drive Pinion Nut	M45 x 1.5	1000-1230	1360-1670
Brake Spider-to-Housing	0.625"-18	180-230	244-312
	M16x2	180-230	244-312
Wheel Stud-to-Hub	0.875"-14	175-250	237-339
Axle Shaft Oil Fill Plug		10 Min.	13.5 Min.
Brake Rotor-to-Hub Capscrew	0.625"-18	180-230	244-312
Torque Rod Bracket Capscrew	M20x2.5	340-400	460-540
ABS Sensor Mount Block Capscrew	M6x1	8-12	11-16

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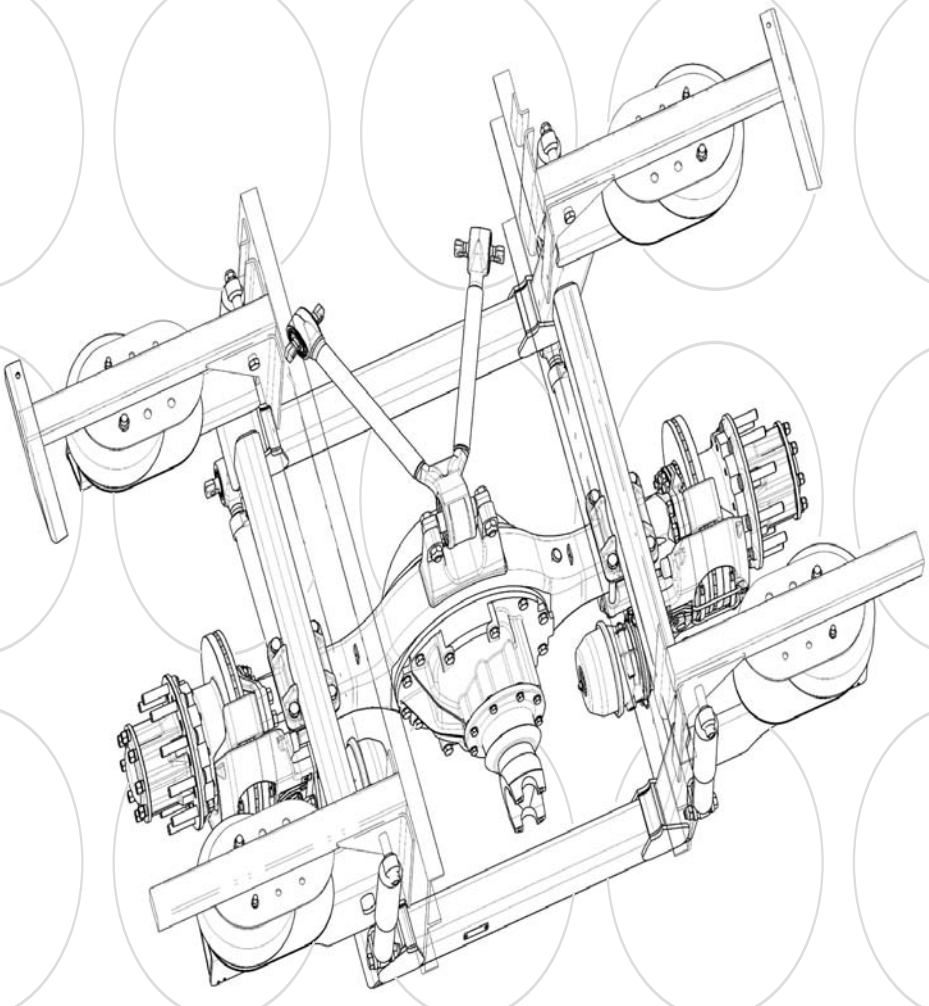
Maintenance Manual MM-0374

RideStar™ RFA Series Rear Air Suspension System

Issued 06-04



Service Notes

About This Manual

This publication provides maintenance and service procedures for the Meritor RideStar™ RFA Series rear air suspension system.

Before You Begin

1. Read and understand all instructions and procedures before you begin to service components.
2. Read and observe all Warning and Caution hazard alert messages in this publication. They provide information that can help prevent serious personal injury, damage to components, or both.
3. Follow your company's maintenance and service, installation, and diagnostics guidelines.
4. Use special tools when required to help avoid serious personal injury and damage to components.

Hazard Alert Messages and Torque Symbols

⚠ WARNING

A Warning alerts you to an instruction or procedure that you must follow exactly to avoid serious personal injury and damage to components.

⚠ CAUTION

A Caution alerts you to an instruction or procedure that you must follow exactly to avoid damage to components.

This symbol alerts you to tighten fasteners to a specified torque value.

How to Obtain Additional Maintenance and Service Information

On the Web

Visit the DriveTrain Plus™ by ArvinMeritor Tech Library at arvinmeritor.com to easily access product and service information. The Library also offers an interactive and printable Literature Order Form.

ArvinMeritor's Customer Service Center

Call ArvinMeritor's Customer Service Center at 800-535-5560.

Technical Electronic Library on CD

The DriveTrain Plus™ by ArvinMeritor Technical Electronic Library on CD contains product and service information for most Meritor and Meritor WABCO products. $20. Specify TP-9853.

How to Obtain Tools and Supplies Specified in This Manual

Call ArvinMeritor's Commercial Vehicle Aftermarket at 888-725-9355 to obtain Meritor tools and supplies.

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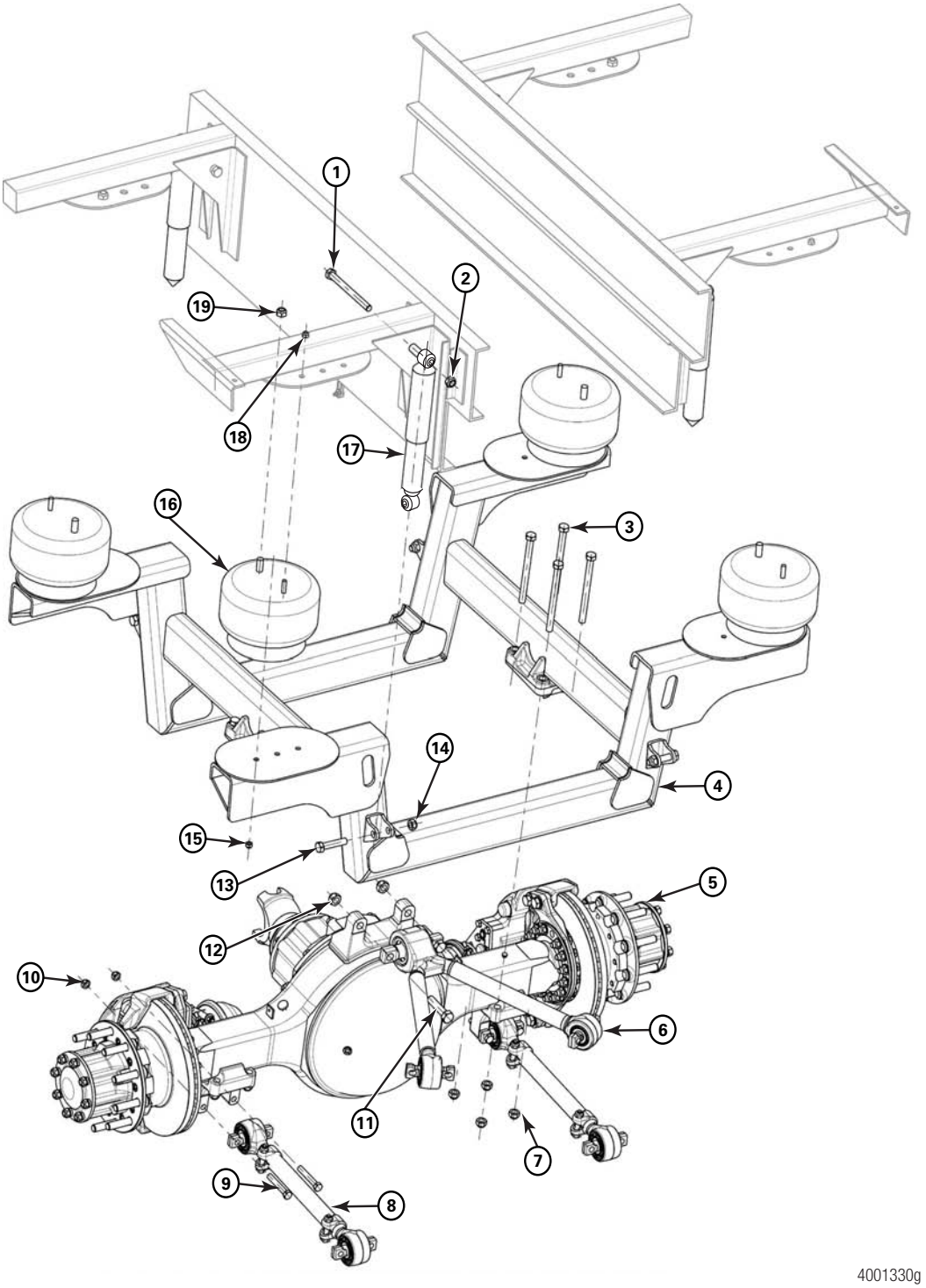
1 Exploded View



1 Exploded View

Item	Description
1	Shock Absorber Upper Capscrew
2	Shock Absorber Upper Locknut
3	Axle Mounting Capscrew
4	Frame Assembly
5	Axle Assembly
6	Upper Torque Rod Assembly
7	Axle Mounting Locknut
8	Lower Torque Rod
9	Lower Torque Rod Capscrew
10	Lower Torque Rod Locknut
11	Upper Torque Rod Capscrew
12	Upper Torque Rod Locknut
13	Shock Absorber Lower Capscrew
14	Shock Absorber Lower Locknut
15	Air Spring Lower Locknut
16	Air Spring
17	Shock Absorber
18	Air Spring Upper 1/2″ Locknut
19	Air Spring Upper 3/4″ Locknut

2 Introduction

Description

Meritor RideStar™ RFA Series rear air suspension systems have a parallelogram design with four air springs and four links. The suspension has a "V" style, upper torque rod assembly and two longitudinal lower torque rods. The RFA is an integrated system that includes a Meritor drive axle and brakes. For information about the other Meritor components, refer to the appropriate maintenance manual. To obtain these publications, refer to the Service Notes page on the front inside cover of this manual.

Components

Key inspection and maintenance areas of the RFA suspension are:

- Frame and frame welds
- Upper and lower torque rods
- Shock absorbers
- Air springs

Refer to the appropriate Meritor maintenance manuals and technical bulletins for axle and brake component inspection and maintenance procedures. To obtain these publications, refer to the Service Notes page on the front inside cover of this manual.

Features

The RFA suspension features:

- A 23,000 lb. (10 430 kg) capacity single rear axle air suspension
- A four link, four air spring base construction
- A nominal ride height of 8.94-inches (227 mm) with 7.13-inches (181 mm) of total travel, 3.7-inches (94 mm) of jounce and 3.43-inches (87 mm) of rebound

Identification

The suspension identification tag is located on the front of the frame assembly, near the middle of the crossmember. Figure 2.1.

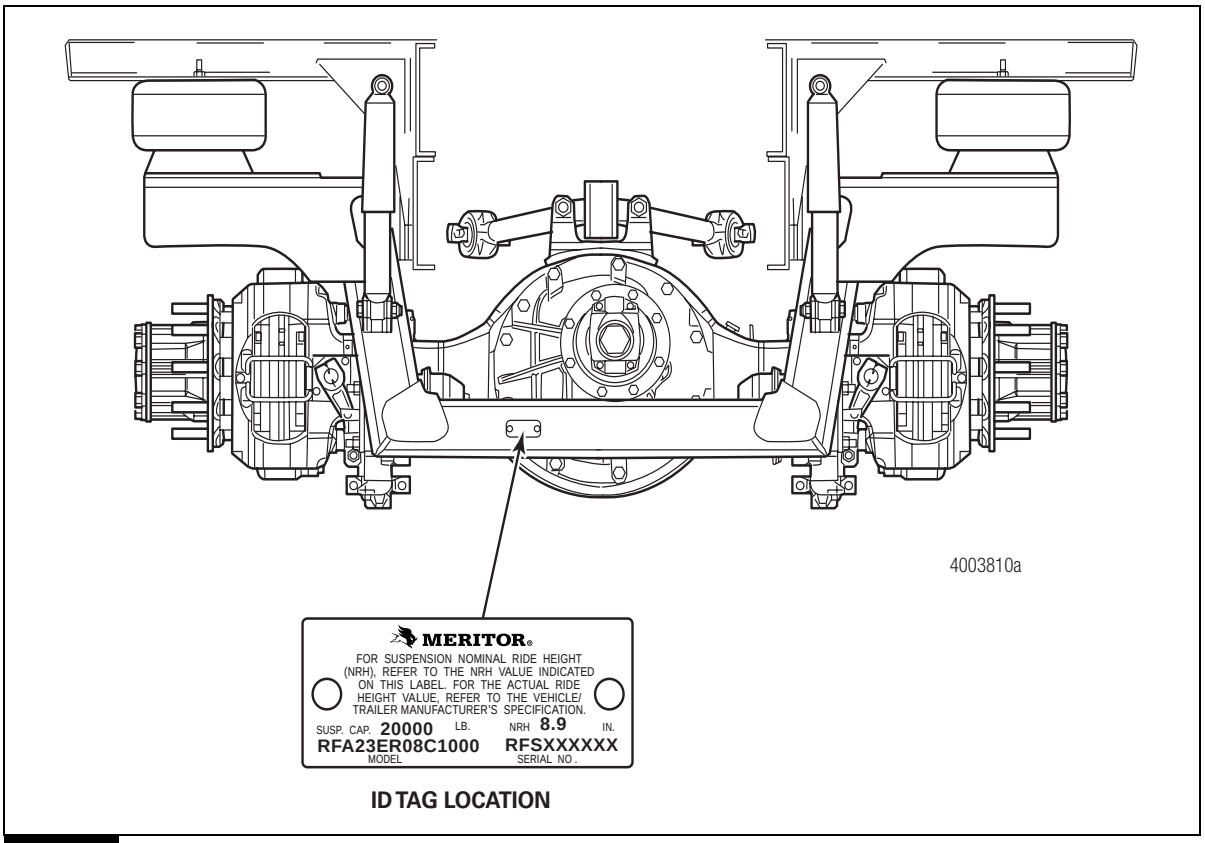


Figure 2.1

Model Numbers and Designations

The model number on the identification tag provides suspension and axle information. Figure 2.2.

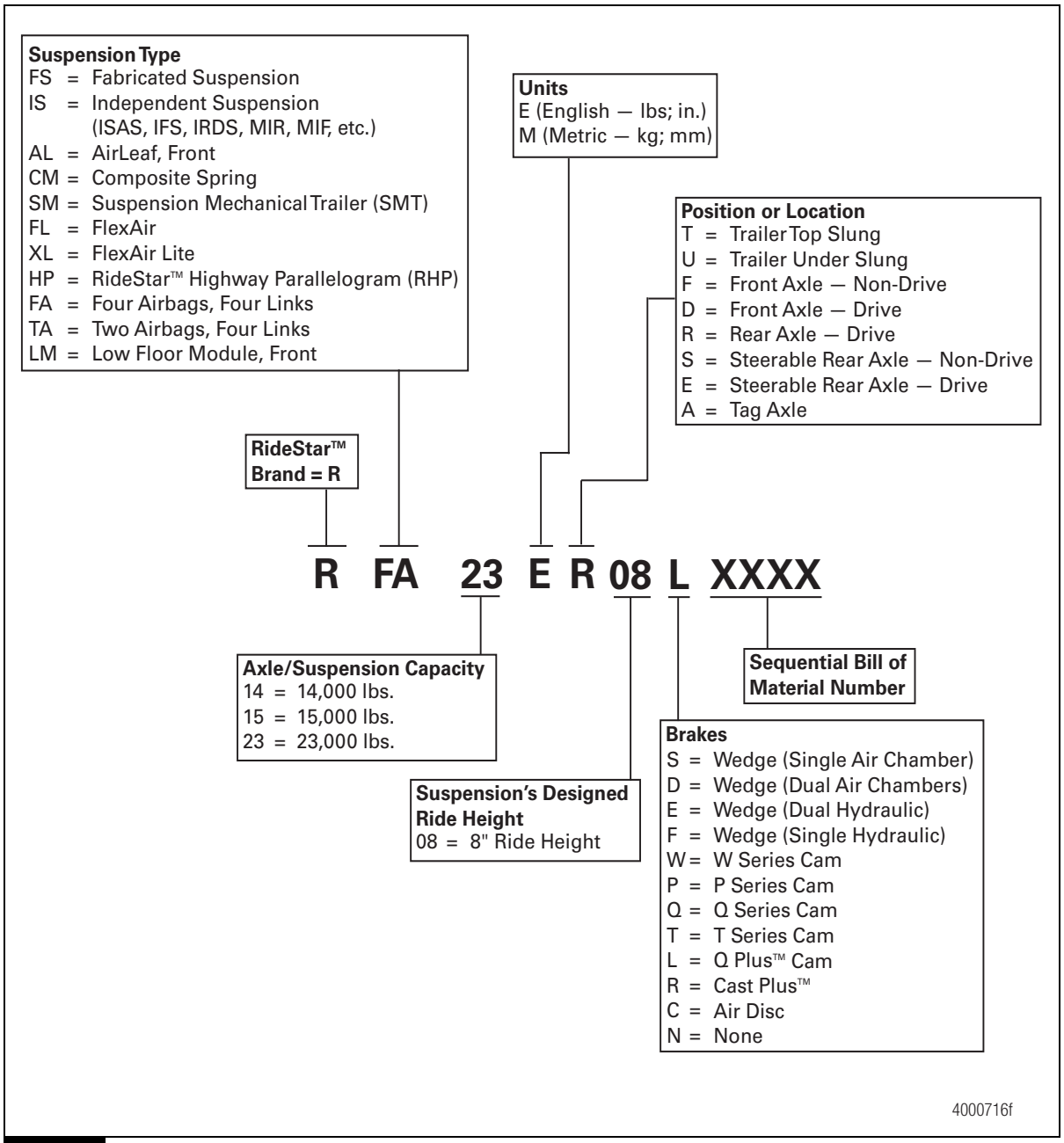


Figure 2.2

3 Suspension Ride Height, Travel and Tire Clearance

Suspension Ride Height

Suspension ride height is the distance from the centerline of the axle to the underside of the vehicle frame. Figure 3.1.

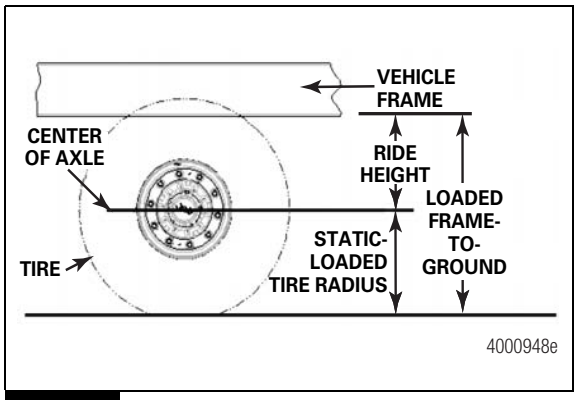


Figure 3.1

All Meritor air suspensions are designed to operate at a specific ride height, which must be maintained during the life of the suspension. Otherwise incorrect loading can occur, which can affect suspension performance, shorten component life and void the Meritor warranty.

Operating a vehicle with ride height higher than specified by the application can cause the vehicle to be over the legal height limit, depending on the type of vehicle and payload.

To obtain the correct ride-height specification, check the suspension's identification tag located on the rear of the frame assembly. Also refer to Section 2.

How to Determine the Correct Ride Height

Consider the following factors when you determine the correct suspension ride height.

Vehicle Frame-to-Ground Distance

You must measure the distance from the bottom of the vehicle frame to the ground at each suspension location. Figure 3.2. This measurement determines the required vehicle height. Refer to the vehicle manufacturer's information for ride height specifications and adjustment procedures.

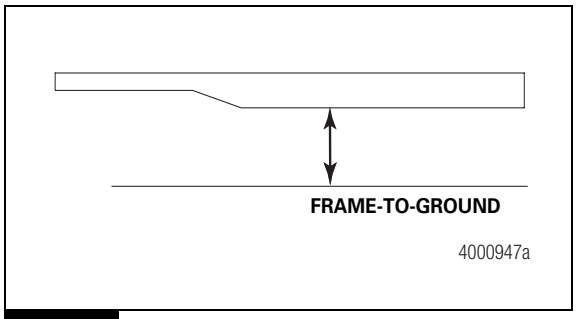


Figure 3.2

Suspension Ride Height Calculation

To calculate the required suspension ride height, subtract the tire's static-loaded radius from the loaded frame-to-ground dimension. Figure 3.1.

Suspension Travel

Jounce and Rebound

Jounce is the amount of upward axle travel from the suspension's designed ride-height position. Figure 3.3. The RFA suspension has 3.7-inches (94 mm) of jounce.

Rebound is the amount of downward axle travel from the suspension's designed ride-height position. Figure 3.3. The RFA suspension has 3.43-inches (87 mm) of rebound.

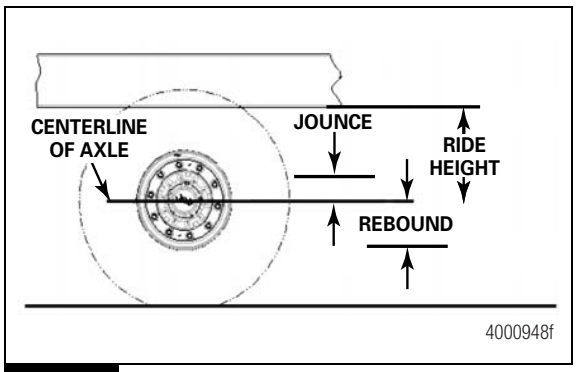


Figure 3.3

Tire Clearance

Meritor's RFA air suspension requires 1.5-inches (38 mm) minimum tire clearance between the top of the tire and the vehicle frame structure above the tire when the suspension is at full jounce. Figure 3.4.

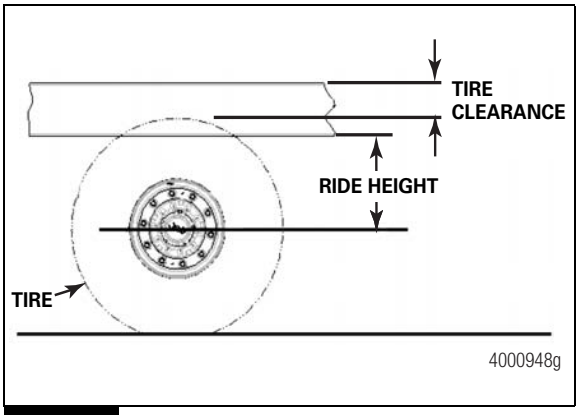


Figure 3.4

How to Determine Tire Clearance

Determine tire clearance by adding the specified tire clearance to the suspension jounce. This sum is the distance required between the top of the tire and the top of the vehicle frame when the suspension is at its designed ride height.

Example

- Jounce = 3.7-inches (94 mm)
- Tire Clearance = 1.5-inches (38 mm)

Calculation

3.7-inches (94 mm) + 1.5-inches (38 mm) = 5.2-inches (132 mm) = Space required above the tire at ride height

A 2-inch (51 mm) clearance is required between the inside of the tire and the vehicle frame on each side. This clearance allows for both lateral movement of the suspension and tire deflection. Figure 3.5.

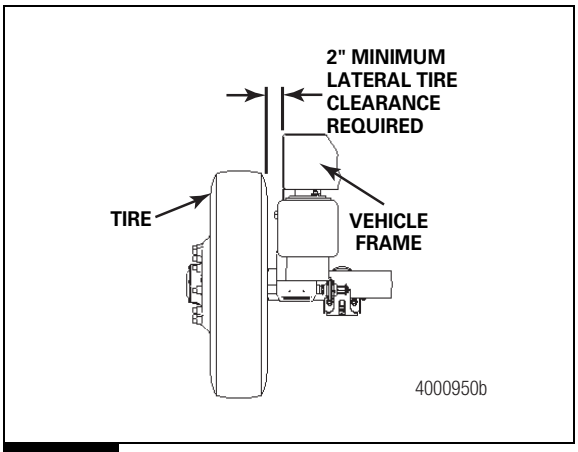


Figure 3.5

4 Inspection

Hazard Alert Messages

Read and observe all Warning and Caution hazard alert messages in this publication. They provide information that can help prevent serious personal injury, damage to components, or both.

⚠ WARNING

To prevent serious eye injury, always wear safe eye protection when you perform vehicle maintenance or service.

Replace damaged or out-of-specification suspension components. Do not bend, repair or recondition suspension components by welding or heat-treating. Serious personal injury and damage to components can result.

Intervals

Inspect the suspension and air suspension components annually or at regular intervals during normal operation.

Before each trip, visually inspect the suspension system and listen for air leaks.

Inspect the shock absorbers, air springs and rubber bushings when the axle or brakes are inspected. Replace the components as necessary.

After 1,000 miles (1609 km) of service on a new vehicle and after component replacement, tighten all fasteners to the specified torque. Refer to Section 7 for torque specifications.

At each preventive maintenance inspection, or annually, visually inspect all fasteners for looseness or movement. Tighten loose fasteners to the specified torque. Refer to Section 7 for torque specifications.

Replace damaged fasteners to maintain the specified torque and to comply with warranty requirements.

NOTE: When replacing any suspension component, never reuse capscrews, washers or locknuts.

Shock Absorbers

The following conditions may indicate that the shock absorbers should be replaced. If any of these conditions exist, inspect the shock absorbers and repair or replace parts as necessary.

- Uneven tire wear. Check balance before replacing the shock absorbers.
- Poor ride quality
- Excess vibration
- Premature wear on electrical and cooling system components
- Damaged air springs
- Leaking shock absorber

Inspection

Inspect the shock absorbers for the following conditions. If any of these conditions exist, repair or replace parts as necessary. Figure 4.1.

- Damaged upper or lower mount
- Damaged upper or lower bushing
- Incorrect installation
- Damaged dust tube
- Bent or dented shock absorber body

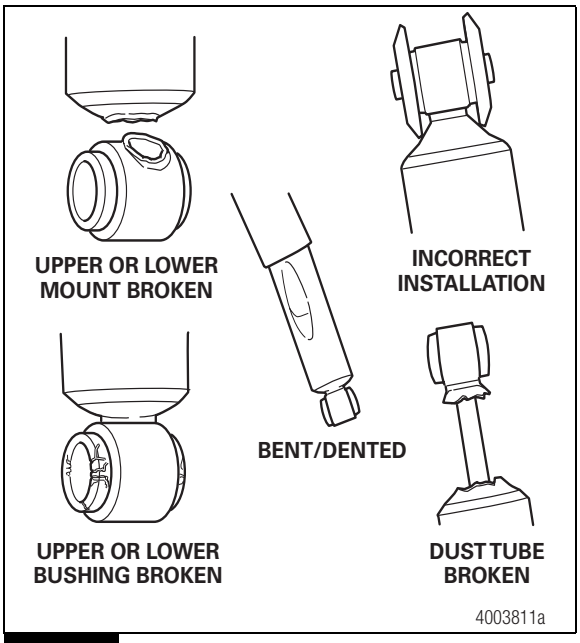


Figure 4.1

Leaking Shock Absorbers

Misting shock absorbers are often misdiagnosed as leaking shock absorbers. Misting occurs when very small amounts of shock absorber fluid evaporate at high operating temperatures through the shock absorber upper seal. When the mist reaches the cooler outside air, it condenses and forms a film on the outside of the shock absorber body.

When mixed with road debris and dust, a grime will often coat the entire body of the shock absorber. Misting is a normal and necessary function of the shock absorber. The evaporating fluid lubricates the seal. A leaking shock absorber will have fluid leaking in streams from the upper seal. Inspect the shock absorbers for leaking when the shock absorber is fully extended. Figure 4.2.

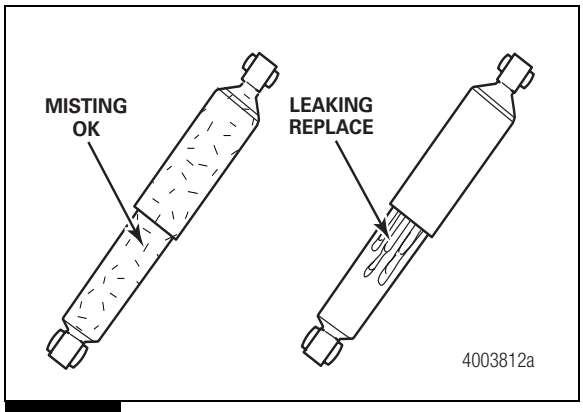


Figure 4.2

Heat Test

Shock absorbers operate at temperatures between ambient and 350°F (177°C). Shock absorbers should be slightly warm or hot after normal use. If poor ride quality exists and you suspect the shock absorber is not operating correctly, perform the following heat test.

1. Drive the vehicle at moderate speeds for at least 15 minutes.
2. Within a few minutes of driving the vehicle, touch the chassis near the shock absorber and then carefully touch each shock absorber body below the dust cover or tube. All shock absorbers should be warmer than the chassis.
   - **If a shock absorber is cooler than the chassis or the shock absorber on the other end of the axle:** Inspect the shock absorber for possible damage. If necessary, remove the cooler shock absorber.
3. Shake the shock absorber to check it for internal damage. Listen for metal parts rattling inside the shock absorber. Loose metal parts inside the shock absorber can indicate internal damage.

Torque Rods

Torque rods maintain the axle position. The upper torque rod maintains the lateral, axial and rotational position. The lower torque rods maintain the axial and rotational position. Worn torque rods can cause more than jerky stops and starts. They can also cause excessive tire wear, seal leaks, axle housing fatigue, ring and pinion gear wear and U-joint/driveline failures.

The mounting bracket that attaches the torque rod to the chassis is supplied by the vehicle manufacturer. It is important to check the tightening torque of the capscrew and locknuts during each preventive maintenance inspection. Refer to the vehicle manufacturer's information and Section 7 for torque specifications.

Bar Pin Bushings

Inspect all of the bar pin bushings in the upper and lower torque rods. Use a two-foot (61cm) pry bar to check the arm pivot bushings for looseness and wear. Replace the bushings if any free play is detected. Check each location in both axial and radial directions.

Separation of the elastomer off the bar pin is permissible up to a third (1/3) of the circumference.

Replacement is also necessary if the following wear characteristics are determined:

1. Cracks or fracture of the metal parts of the bushing. Figure 4.3.

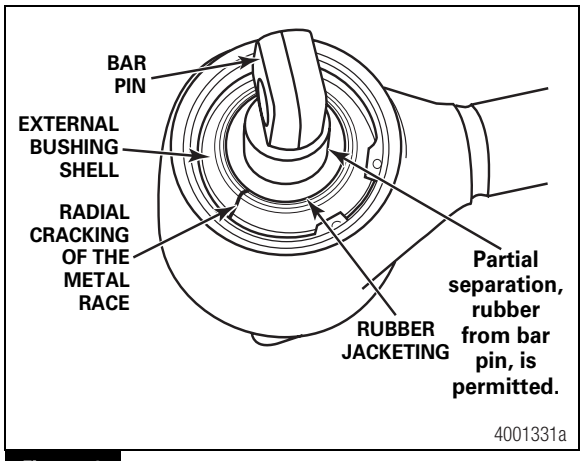


Figure 4.3

4 Inspection

2. Plastic deformation of the sheet-metal race
3. Inadequate bolted connection, i.e., loosened, broken or lost bolt
4. Damage to the circlip, circlip detached from the groove, broken or lost

- **If damage to the inner housing contour or the circlip groove is determined during replacement of the elastomeric bearing:** Replace the entire torque rod.

Hazard Alert Messages

Read and observe all Warning and Caution hazard alert messages in this publication. They provide information that can help prevent serious personal injury, damage to components, or both.

⚠ WARNING

To prevent serious eye injury, always wear safe eye protection when you perform vehicle maintenance or service.

Park the vehicle on a level surface. Block the wheels to prevent the vehicle from moving. Support the vehicle with safety stands. Do not work under a vehicle supported only by jacks. Jacks can slip and fall over. Serious personal injury and damage to components can result.

Verify that all personnel are clear of the vehicle before you inflate or deflate the air springs. The air suspension system has various pinch points that can cause serious personal injury.

Removal

Air Spring

NOTE: When you replace the air springs on an RFA series suspension, you must install Meritor components or components purchased from a Meritor-approved distributor. Use of non-approved components will affect suspension performance and void the Meritor warranty.

1. Park the vehicle on a level surface. Block the wheels to prevent the vehicle from moving.
2. Raise the vehicle so that the suspension is at or above the designed ride height. Support the rear of the vehicle with safety stands. Refer to the vehicle manufacturer's instructions for the correct safety stand placement locations.
3. Drain the air pressure from the air system.
4. Disconnect the air line from the air spring.
5. Remove the locknuts from the top and bottom of the air spring. Discard the locknuts.
6. Compress the air spring until the studs clear the upper and lower mounting plates.
7. Remove the air spring from the vehicle.

Shock Absorber

⚠ WARNING

The suspension is equipped with gas-pressurized shock absorbers. Heat or flame can cause the shock absorbers to extend unassisted. Do not apply heat or flame to the shock absorbers during removal or component servicing. Failure to follow these instructions can result in serious personal injury.

1. Park the vehicle on a level surface. Block the wheels to prevent the vehicle from moving.

NOTE: Shock absorbers act as suspension rebound stops. Do not remove the shock absorbers if the vehicle is raised and the axle is not supported.

2. Remove the shock absorber upper capscrew and locknut. Discard the capscrew and locknut.
3. Remove the shock absorber lower capscrew and locknut. Discard the capscrew and locknut.
4. Remove the shock absorber from the vehicle.

Upper Torque Rod

1. Park the vehicle on a level surface. Block the wheels to prevent the vehicle from moving.
2. Raise the rear of the vehicle until the rear wheels are off the ground. Support the rear of the vehicle and the rear axle with safety stands. Refer to the vehicle manufacturer's instructions for the correct safety stand placement locations.
3. Remove the two capscrews and locknuts that secure the upper torque rod assembly to the axle housing. Discard the capscrews and locknuts.
4. Refer to the vehicle manufacturer's instructions to remove the fasteners that secure each upper torque rod arm to the frame crossmember.
5. Remove the upper torque rod assembly from the vehicle.

5 Removal

Lower Torque Rod

1. Park the vehicle on a level surface. Block the wheels to prevent the vehicle from moving.
2. Raise the rear of the vehicle until the rear wheels are off the ground. Support the rear of the vehicle and the rear axle with safety stands. Refer to the vehicle manufacturer's instructions for the correct safety stand placement locations.
3. Remove the two capscrews and locknuts that secure each lower torque rod to the axle housing. Discard the capscrews and locknuts.
4. Refer to the vehicle manufacturer's instructions to remove the fasteners that secure each lower torque rod to the vehicle.
5. Remove the lower torque rods from the vehicle.

Hazard Alert Messages

Read and observe all Warning and Caution hazard alert messages in this publication. They provide information that can help prevent serious personal injury, damage to components, or both.

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To prevent serious eye injury, always wear safe eye protection when you perform vehicle maintenance or service.

Park the vehicle on a level surface. Block the wheels to prevent the vehicle from moving. Support the vehicle with safety stands. Do not work under a vehicle supported only by jacks. Jacks can slip and fall over. Serious personal injury and damage to components can result.

Verify that all personnel are clear of the trailer before you inflate or deflate the air springs. The air suspension system has various pinch points that can cause serious personal injury.

Installation

Lower Torque Rod

1. Position the lower torque rods onto the axle housing.
2. Install two new capscrews and locknuts into each lower torque rod and axle housing. Tighten the locknuts to 150-190 lb-ft (203-258 N•m).
3. If the torque rod is adjustable, adjust the length of the new torque rod to match the length of the old torque rod that is being replaced. Tighten the adjustment clamp fasteners to 85-100 lb-ft (115-135 N•m).
4. Refer to the vehicle manufacturer's instructions to install the fasteners that secure each lower torque rod to the vehicle.

Upper Torque Rod

1. Position the upper torque rods onto the axle housing.
2. Install two new capscrews and locknuts into the upper torque rod assembly and axle housing. Tighten the locknuts to 450-550 lb-ft (610-746 N•m).
3. Refer to the vehicle manufacturer's instructions to install the fasteners that secure each upper torque rod arm to the frame crossmember.

Shock Absorber

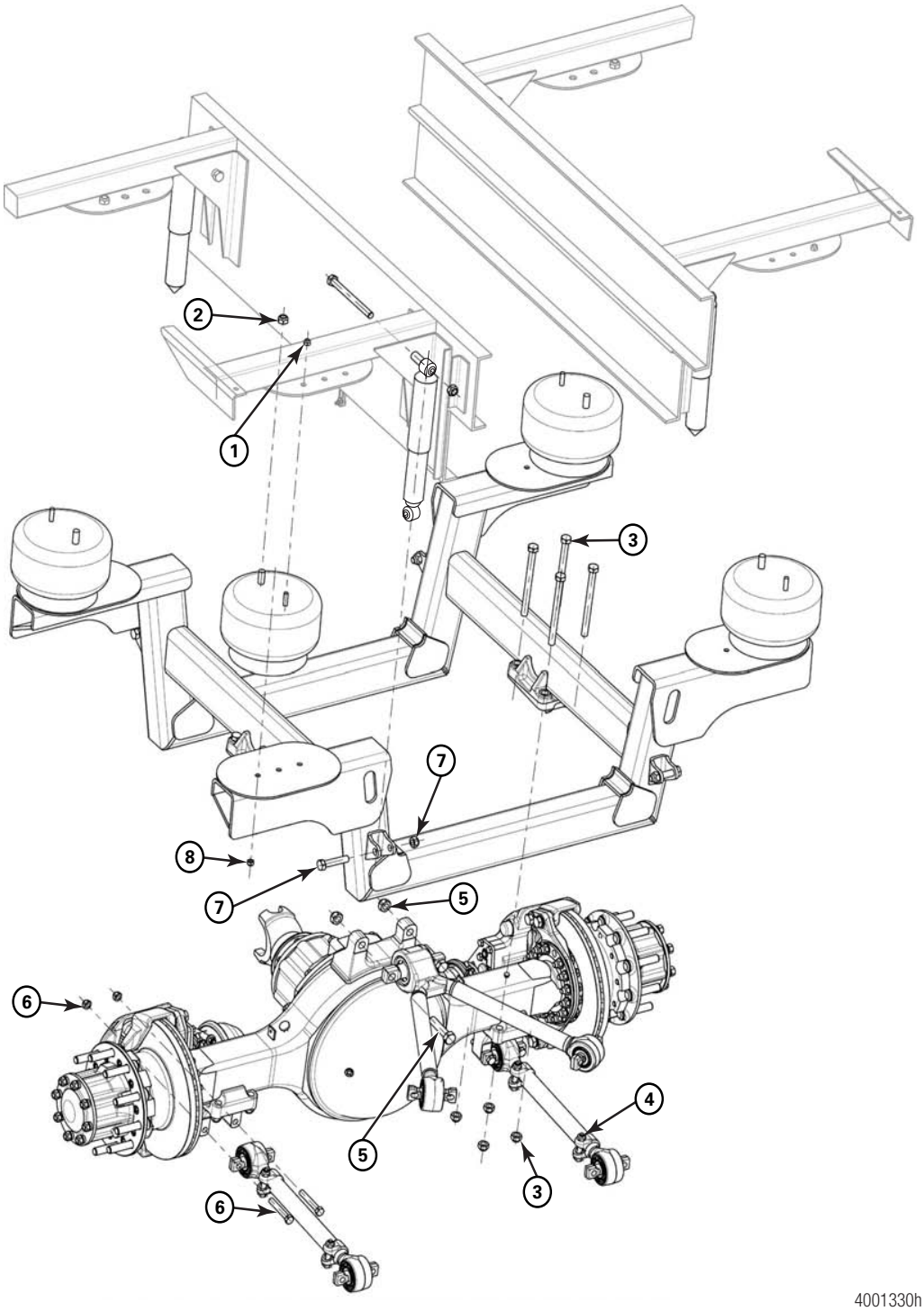
1. Refer to the vehicle manufacturer's instructions to install the shock absorber at the upper mount location on the frame.
2. Compress or extend the shock absorber until the lower fastener point is aligned with the lower mount on the suspension.
3. Install a new capscrew and locknut to secure the shock absorber in the lower mount. Tighten the locknut to 270-350 lb-ft (366-474 N•m).

Air Spring

1. Support the vehicle with safety stands. Refer to the vehicle manufacturer's instructions for the correct safety stand placement locations.
2. Compress the air spring and install it between the upper and lower air spring plates.
3. Install a new locknut onto the mounting stud on the bottom of the air spring. Tighten the locknut to 20-30 lb-ft (27-41 N•m).
4. Refer to the vehicle manufacturer's instructions to secure the air spring to the upper mounting locations.
5. Connect the air line to the air spring.

7 Specifications

Torque Specifications

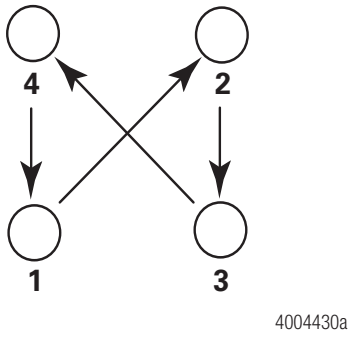


4001330h

7 Specifications

Item	Description	Size	Torque Value	
			Lb-Ft	N•m
1	Air Spring Upper Locknut	1/2″	20-30	27-41
2	Air Spring Lower Locknut	3/4″	40-50	54-68
3	Axle Mounting Capscrew and Locknut	3/4″ x 9.5″	300-350[1]	407-474
4	Lower Torque Rod Adjusting Clamp Capscrew and Locknut	5/8″ x 11″	85-100	115-135
5	Upper Torque Rod Assembly Capscrew and Locknut	7/8″ x 3.75″	450-550	610-746
6	Lower Torque Rod Capscrew and Locknut	5/8″ x 4″	150-190	203-258
7	Shock Absorber Lower Capscrew and Locknut	3/4″ x 3.5″	270-350	366-474
8	Air Spring Lower Locknut	1/2″	20-30	27-41

[1] Tighten all eight axle mounting capscrews and locknuts hand tight. Then progressively tighten to specification in a crossing pattern as shown in Figure 7.1.



AXLE MOUNTING CAPSCREW AND LOCKNUT TIGHTENING SEQUENCE

Figure 7.1

NOTE: After tightening, verify the torque on all fasteners. If one is low, retighten all fasteners.

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MERITOR®

Technical Bulletin

DiscPlus™ DX195 and DX225 Air Disc Brakes

Inspection, Installation and Diagnostics

Air Disc Brake Inspection Intervals and Procedures

⚠ ASBESTOS AND NON-ASBESTOS FIBERS WARNING

Some brake linings contain asbestos fibers, a cancer and lung disease hazard. Some brake linings contain non-asbestos fibers, whose long-term effects to health are unknown. You must use caution when you handle both asbestos and non-asbestos materials.

⚠ WARNING

To prevent serious eye injury, always wear safe eye protection when you perform vehicle maintenance or service.

Park the vehicle on a level surface. Block the wheels to prevent the vehicle from moving. Support the vehicle with safety stands. Do not work under a vehicle supported only by jacks. Jacks can slip and fall over. Serious personal injury and damage to components can result.

Intervals

Periodically inspect the brakes. Check the stroke length and inspect the brake components for signs of wear and damage.

Use the schedule below that gives the most frequent inspections.

- Fleet chassis lubrication schedule
- Chassis manufacturer lubrication schedule
- At least four times during lining life
- At tire replacement

Check the Push Rod Travel or Adjusted Chamber Stroke Length

Use the following procedure to check the in-service push rod travel or adjusted chamber stroke.

1. Wear safe eye protection. Park the vehicle on a level surface. Block the wheels to prevent the vehicle from moving.
2. The engine must be OFF. Check the gauges in the cab to verify that the air pressure in the tanks is 90-100 psi (620-689 kPa).
3. Release the parking brake.
4. Measure the distance from the bottom of the air chamber to the center of the clevis pin while the brakes are released. This distance should be approximately 1.46-inches (37 mm). Figure 1.
   - **If the distance is greater than 1.62-inches (41 mm):** Refer to the diagnostics table in this bulletin to determine the cause and correct the condition.

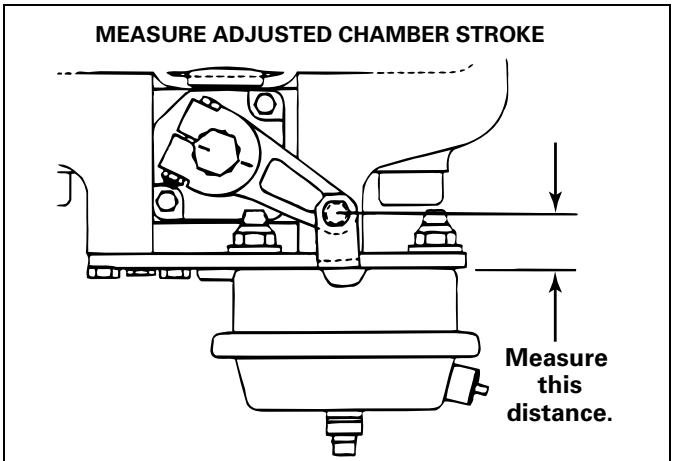


Figure 1

5. Have another person apply and hold the brakes one full application. Measure the distance from the bottom of the air chamber to the center of the clevis pin while the brakes are applied.
6. Subtract the measurement you obtained in Step 4 from the measurement you obtained in Step 5. The difference is the push rod travel or adjusted chamber stroke.
   - **If push rod travel or adjusted chamber stroke is greater than two-inches (51 mm):** Refer to the diagnostics table in this bulletin.
   - **If push rod travel or adjusted chamber stroke is less than 0.88-inches (22 mm):** Readjust the brake. Refer to the initial brake adjustment procedure in this bulletin.

Caliper Assembly Inspection

1. Remove the adjuster plug and washer. Figure 2.

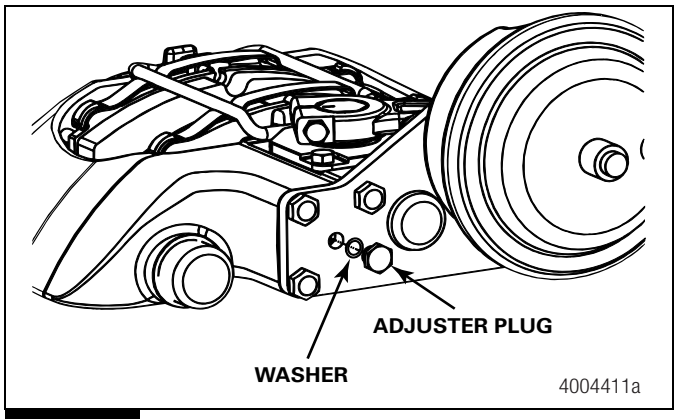


Figure 2

⚠ CAUTION

Always use a 6 mm Allen wrench to manually adjust and de-adjust the brake. Do not use air or power tools. Damage to components can result.

2. Use a 6 mm Allen wrench to de-adjust the brake. Stop turning the Allen wrench when you feel resistance. When you feel resistance, adjust the brake 1/4 turn to ensure that automatic adjustment will occur. Figure 3. Note the location of the air chamber with respect to the adjustment direction.

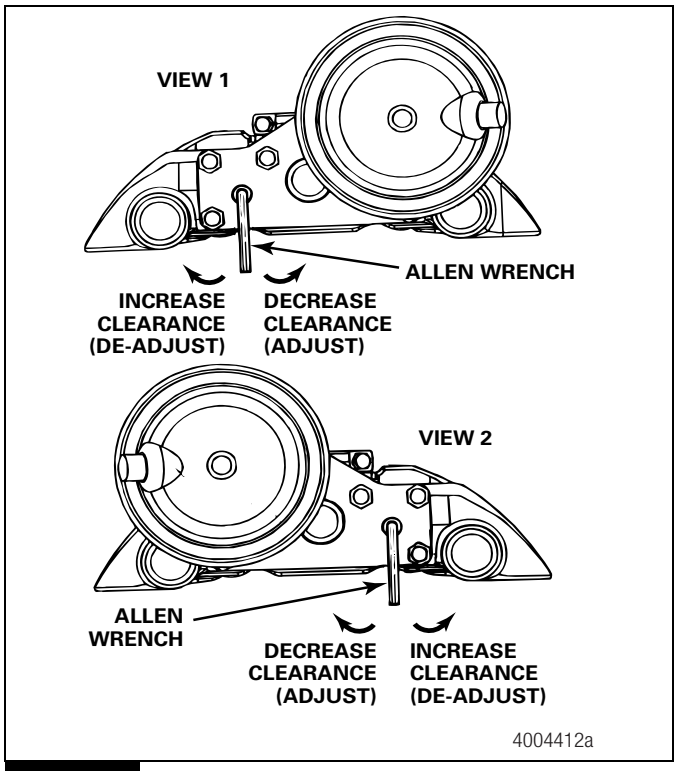


Figure 3

3. Remove the stabilizer bar retainer and cotter pin. Open the bar so that it is out of the way. Figure 4.

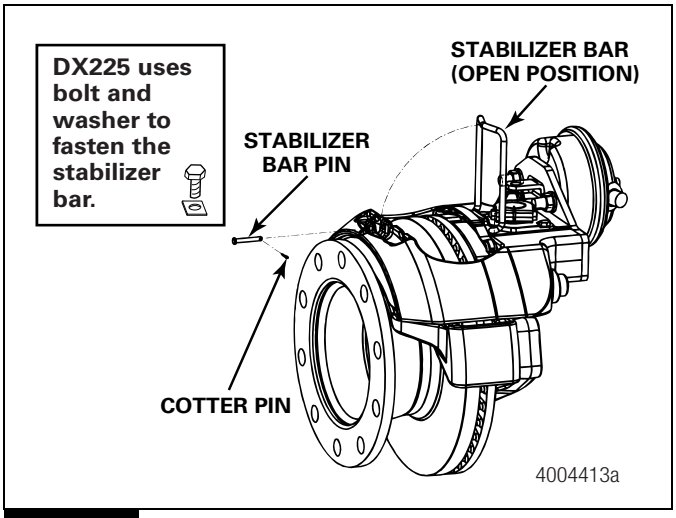


Figure 4

4. Lift the INBOARD brake pad out of the caliper assembly. Mark the brake pad INBOARD. Figure 5.

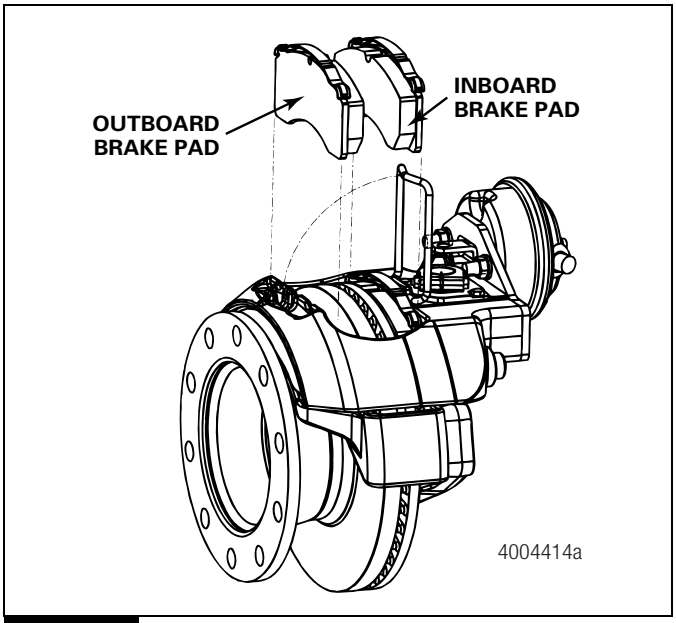


Figure 5

5. Slide the caliper OUTWARD and remove the OUTBOARD brake pad. Mark the brake pad OUTBOARD. Figure 5.

6. Inspect the brake pads for cracked friction material (lining). Check if the friction material is loose or detached from the backing plate. Inspect the anti-rattle springs attached to the brake pad. Replace bent, cracked or broken springs. Figure 6.

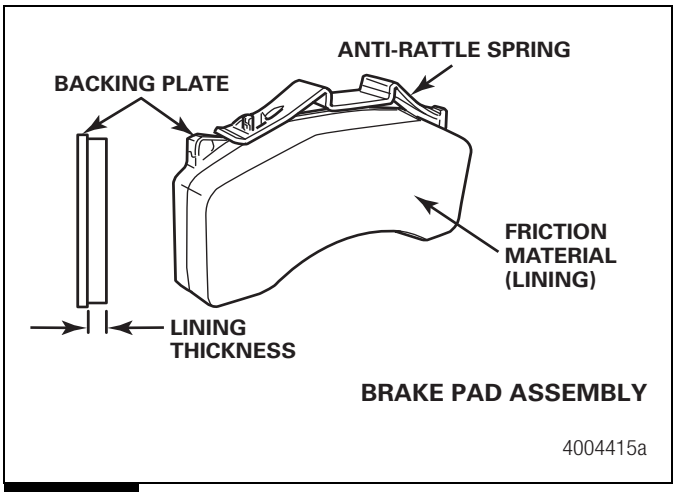


Figure 6

7. Measure the friction material (lining) thickness. Replace the brake pad assembly before the lining thickness reaches 0.200-inch (5.1 mm). Figure 6.
8. Remove dirt or dust from the brake pad contact surfaces of the saddle abutments.
9. Verify that the caliper slides freely on the slide pins. Figure 7.

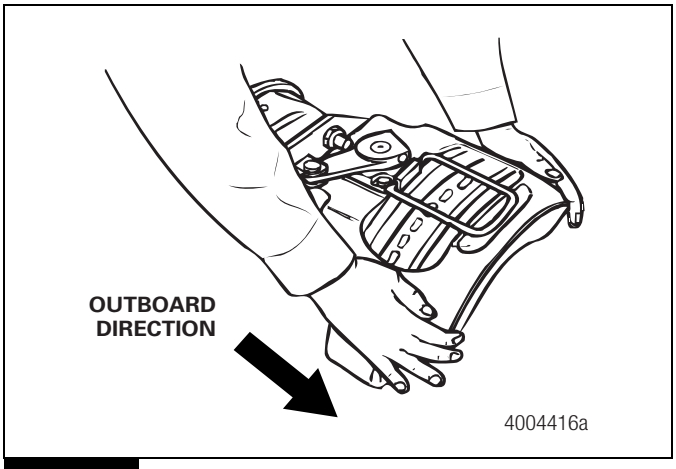


Figure 7

10. Inspect the caliper boots. If the boots are damaged, replace the caliper. Figure 8.
    - **If you are replacing the calipers:** Refer to the caliper assembly removal and installation procedures in this bulletin.

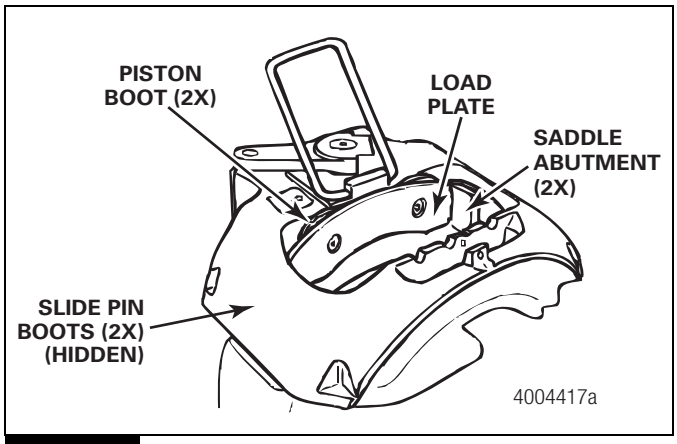


Figure 8

Disc or Rotor Inspection

With the pads removed, rotate the wheel and inspect the rotor. Inspect both sides of the rotor for cracks and heat checks. Replace the rotor, if necessary.

Cracks

⚠ WARNING

Always replace a cracked rotor to avoid serious personal injury and damage to components.

When the crack extends through a section of the rotor, replace the rotor. Figure 9.

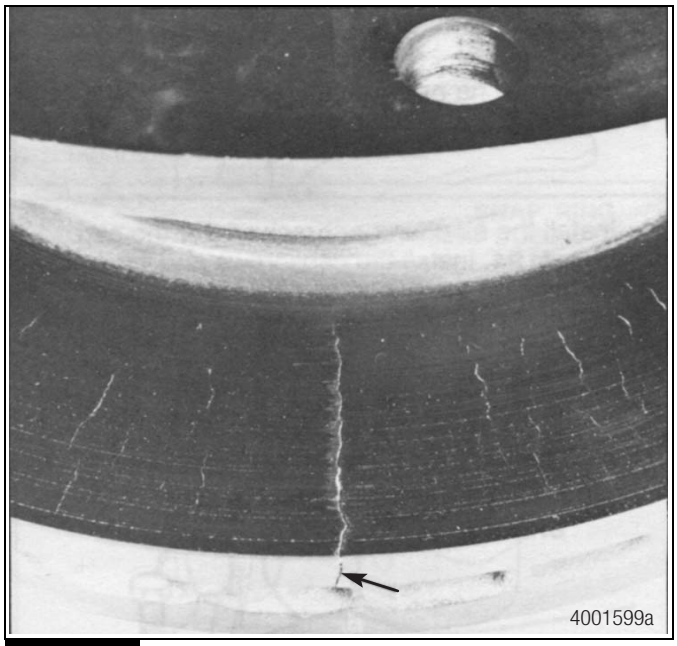


Figure 9

Heat Checking

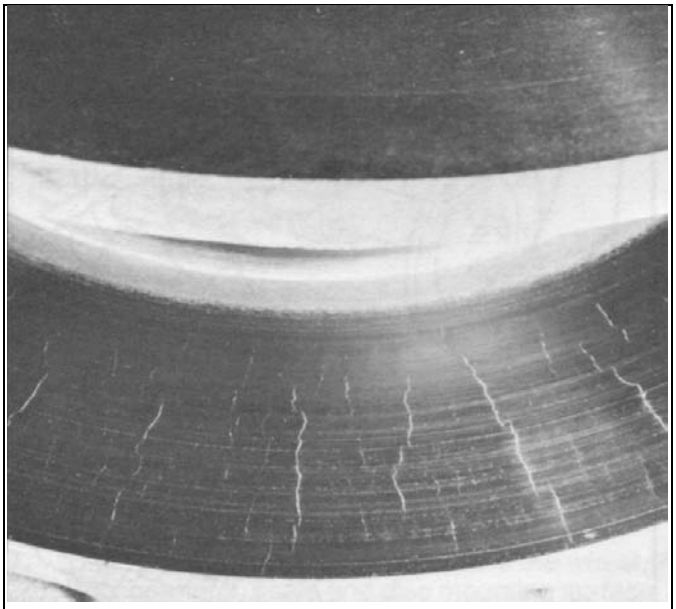
Heat checks are short, thin, sometimes numerous, radial interruptions of the rotor braking surfaces. They are the result of disc brake operation. They are caused by the heating and cooling that occurs as the brakes are applied time after time. Heat checks will frequently wear away and reform, or they may become braking surface cracks, depending on such factors as the lining and rotor wear rate, brake balance, and how hard the brakes are used. There are two kinds of heat checking: light and heavy.

Light Heat Checking

Cracks on the surface of the rotor that result from light heat checking are small and fine and do not require rotor replacement.

Heavy Heat Checking

Heavy heat checking is surface cracks that have width and depth. Figure 10. If you find heavy heat checking, replace the rotor.



4001600a

Figure 10

Deep Grooves or Scores

Inspect both sides of the rotor. If you find deep grooves or scores, replace the rotor. Figure 11. If the grooves or scores are not too deep, you may continue to use the rotor.

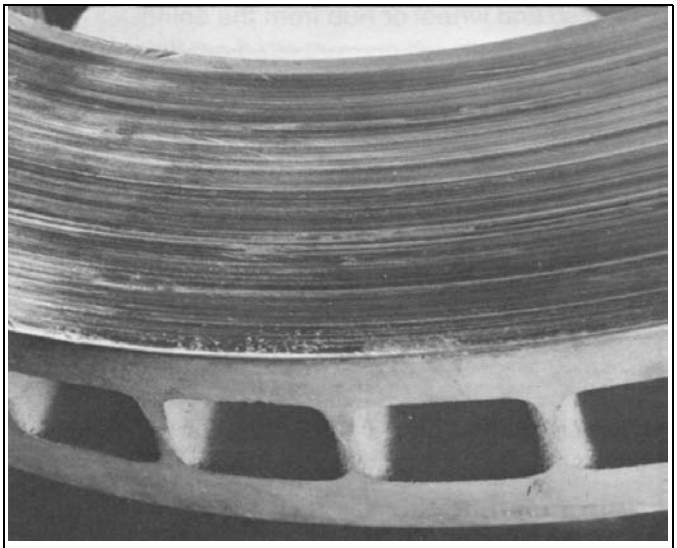


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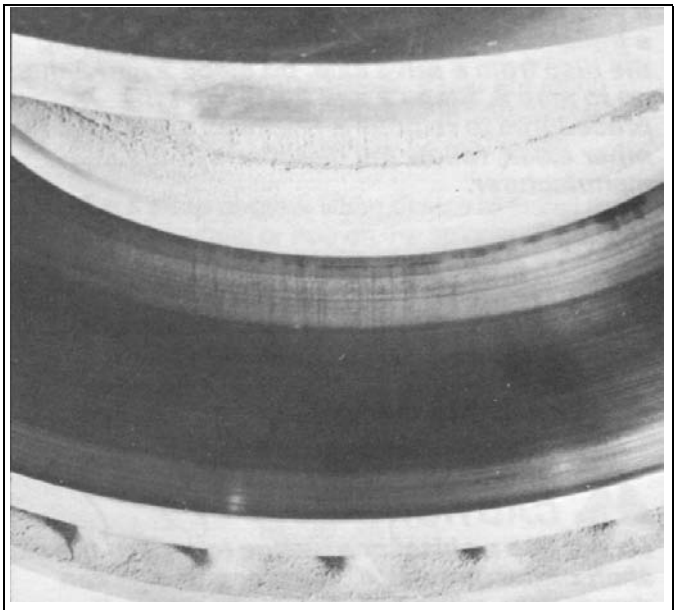
Figure 11

Blue Marks or Bands

Blue marks or bands indicate that the rotor was very hot. Refer to the diagnostics table in this bulletin to determine the cause and correct the condition. Figure 12.



4001602a

Figure 12

Measure the Rotor Thickness

Use a micrometer to measure the rotor thickness. The rotor must be at least 1.626-inches (41.3 mm). Figure 13.

- **If the rotor thickness is less than the specification:** Replace the rotor.

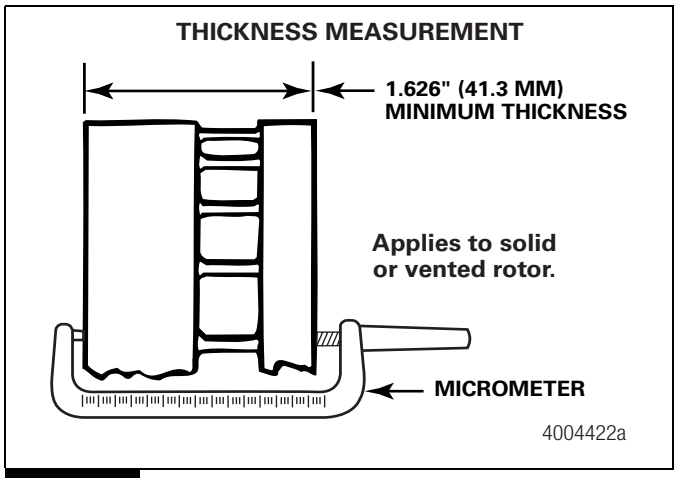


Figure 13

Install the Brake Pads

⚠ CAUTION

Replace the pads on both brakes of a single axle or on all four brakes of a tandem axle at the same time. If you do not replace all the pads at the same time, poor brake performance can occur.

1. Slide the caliper OUTWARD. Install the OUTBOARD pad and spring assembly into the OUTBOARD side of the caliper. Confirm that the load plate is correctly located between the saddle abutments. Figure 8.
2. Slide the caliper INWARD. Install the INBOARD pad and spring assembly into the INBOARD side of the caliper.
3. Close the stabilizer bar. Install the stabilizer bar pin and cotter pin or tighten the hex-head bolt to 23-29 lb-ft (30-40 N•m).

Initial Brake Adjustment

⚠ CAUTION

You must adjust the initial brake pad-to-rotor clearance or an inefficient, dragging brake can occur. Damage to components can result.

1. Use the following procedure to adjust the initial brake pad-to-rotor clearance. The air chamber must be installed and attached to the lever with the clevis pin before you proceed with the initial brake adjustment procedure.
   A. Use a 6 mm Allen wrench to adjust the caliper by reducing the brake pad-to-rotor clearance to ZERO. Figure 3.
   B. Verify that the load plate is in full contact with the brake pad backing plate. Figure 6 and Figure 8.
   C. Increase the brake pad-to-rotor clearance 10 clicks or 3/4 turn (de-adjust) to set the initial clearance. Figure 3.
2. Install the adjuster plug and washer. Tighten to 8-12 lb-ft (11-17 N•m). Figure 2.
3. Have another person make 10 or more brake applications to set the brake pad-to-rotor running clearance. Verify that all air chambers and calipers correctly apply and release during the brake applications.

Remove the Caliper Assembly

⚠ CAUTION

Do not use the stabilizer bar to lift the caliper onto or off of the axle. Damage to the stabilizer bar can result.

1. Remove the clevis pin from the lever.
2. Remove the air chamber.
3. Remove the four saddle bolts. Figure 14.

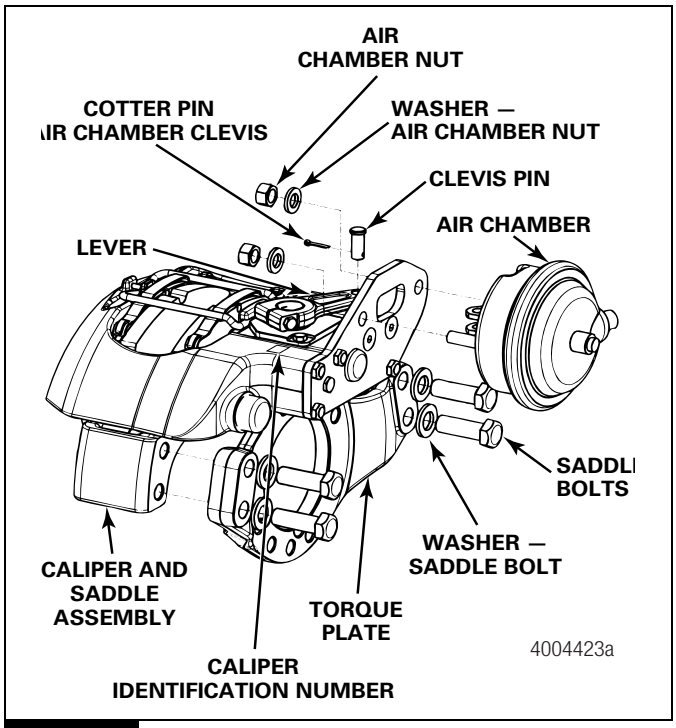


Figure 14

4. Lift the caliper and saddle assembly away from the rotor.

Replace the Rotor

1. Remove the caliper assembly. Refer to the procedure in this bulletin.
2. Remove the hub and rotor assembly. Refer to the axle manufacturer's service manual.

⚠ WARNING

Use a brass or synthetic mallet for assembly and disassembly procedures. Do not hit steel parts with a steel hammer. Pieces of a part can break off. Serious personal injury and damage to components can result.

3. Detach the rotor from the hub. Use one of the following procedures.
   - **For stud-mounted rotors:** Use a brass or synthetic mallet to remove the hub-to-rotor studs. Figure 15. Be careful not to damage the studs during this process.
   - **For bolt-mounted rotors:** Unscrew the hub-to-rotor bolts. Figure 16.

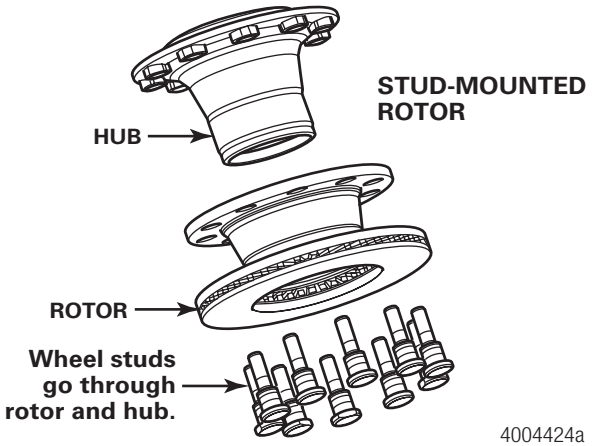


Figure 15

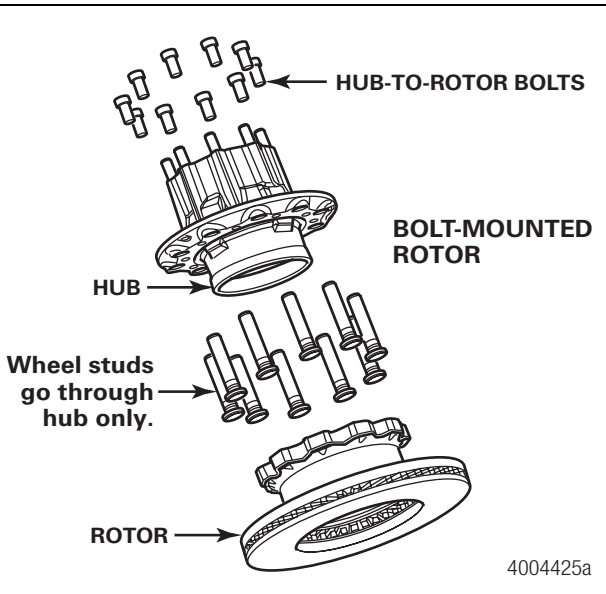


Figure 16

4. Attach a new rotor to the hub.
   - **For stud-mounted rotors:** Press or pull the wheel studs through the rotor into the hub. Figure 15.
   - **For bolt-mounted rotors**: Tighten the hub-to-rotor bolts to 175-195 lb-ft (238-265 N•m). Figure 16. ❶
5. Install the hub and rotor assembly. Refer to the axle manufacturer's service manual.
6. Install the caliper assembly. Refer to the procedure in this bulletin.

Install the Caliper Assembly

1. Place the caliper assembly over the rotor.
2. Align the caliper saddle bolt holes and assemble to the torque plate using saddle bolts and washers.
3. Tighten the saddle bolts to 400-500 lb-ft (544-680 N•m). ❶
4. Mount the air chamber to the caliper assembly. Tighten the air chamber nuts and washers to 133-155 lb-ft (180-210 N•m). ❶
5. Apply a coating of anti-seize compound to the clevis pin. Install the clevis pin and cotter pin.
6. Install the brake pads. Refer to the procedure in this bulletin.

Air Disc Brake Troubleshooting

Diagnostics

DX195 and DX225 Air Disc Brakes

Conditions	Possible Causes	Check For	Corrections
Air chamber exceeds 2″ (51 mm) at 90-100 psi (620-689 kPa) in cab.	Incorrect initial adjustment or inoperative automatic adjuster	Recheck chamber stroke after 20 brake applications.	If the air chamber still overstrokes, then replace the caliper and saddle assembly.
Brake drag	Incorrect initial adjustment	Correct pad-to-rotor clearance	Readjust to set the correct rotor-to-pad clearance.
	Incorrect pad-to-rotor clearance		
	Spring or service brake not releasing	Correct operation of air system or air chamber	Refer to the vehicle manufacturer's instructions. Repair or replace parts as required.
	Vehicle air system malfunction		
	Brake not releasing	Damaged slide pin boots, caliper should move back and forth by hand with linings removed	Replace the caliper assembly.
		Corroded pin in chamber clevis and lever	Clean or replace the clevis pin (apply anti-seize compound before reassembly).
		Incorrect position of load plate between saddle abutments	Remove the brake pads and reinstall. Refer to the procedure in this bulletin.
		Water entry or seized operation shaft, internal	Replace the caliper assembly and air chamber.
	Air line too short	Correct air line length	Replace the air line. Refer to the vehicle manufacturer's instructions.
Short brake pad lining life	Refer to Brake drag.	Refer to Brake drag.	Refer to Brake drag.
	Caliper seized or sticking on slide pins	Damaged slide pin boots, caliper should move back and forth by hand with linings removed	Replace the caliper assembly.
	Damaged rotor surface	Cracks or heavy heat checking	Replace the rotor.
	Vehicle overload	Refer to the weight limitations on the vehicle identification plate.	Observe the vehicle manufacturer's load recommendations.
	Companion brakes do not work correctly	Inspect the companion vehicle brakes and air system.	Adjust or repair as required.
Smoking brakes	High brake temperature	Refer to Brake drag and Short brake pad lining life.	Refer to Brake drag and Short brake pad lining life. Can be a temporary situation with new or low mileage pads.
	Contamination on the linings or rotor	Grease, oil, undercoating, paint, etc., on the linings or rotor	• Inspect the hub seal. Replace as required. • Clean the rotor and caliper assembly. • Replace the pads.

Conditions	Possible Causes	Check For	Corrections
Poor stopping power • **Long stopping distances** • **Poor driver feel** • **High brake pressures** • **Vehicle pulls to one side**	Vehicle air system malfunction	Correct air pressure at the chamber inlet	Have the air system evaluated by a qualified brake system specialist.
	Contamination on the linings or rotor	Grease, oil, undercoating, paint, etc., on the linings or rotor	• Inspect the hub seal. Replace as required. • Clean the rotor and caliper assembly. • Replace the pads.
	Brakes out-of-adjustment	Excessive pad-to-rotor clearance	Readjust to set the correct pad-to-rotor clearance.
	Vehicle overload	Refer to the weight limitations on the vehicle identification plate.	Observe the vehicle manufacturer's load recommendations.
	Companion brakes not working correctly	Inspect the companion vehicle brakes and air system.	Adjust or repair as required.
	Incorrect pads installed	Refer to the vehicle manufacturer for the correct pads.	Replace the pads.
Brake noise	Incorrect pad installation	Friction material facing the rotor surface	Correct the pad installation. Replace the pads and rotor, if necessary.
	Brake pads not free to move in the caliper	Corrosion or debris on the pads or carrier abutments	Clean or replace the pads, if necessary. Clean the pad abutments on the carrier.
	Worn brake pads	Lining thickness	Replace the pads, if necessary.
	Brake component attachments are not installed to specification	Check for loose connections and fasteners.	Tighten the connections and fasteners to the specified torque.
	Rotor cracks or excessive runout	Excessive cracking, heat checking or runout	Replace the rotor.
	Pad spring damaged or not installed	Correct pad spring installation	Install the pad springs.
	Incorrect pads installed	Refer to the vehicle manufacturer for the correct pads.	Replace the pads.
	Bent or loose pad retainer	Bent pad retainer or loose pad retainer bolt	Replace or tighten the pad retainer.

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Bendix

Service Data

SD-13-4746

Bendix® Gen 4™ and Gen 5™ ABS for Trucks, Tractors, and Buses

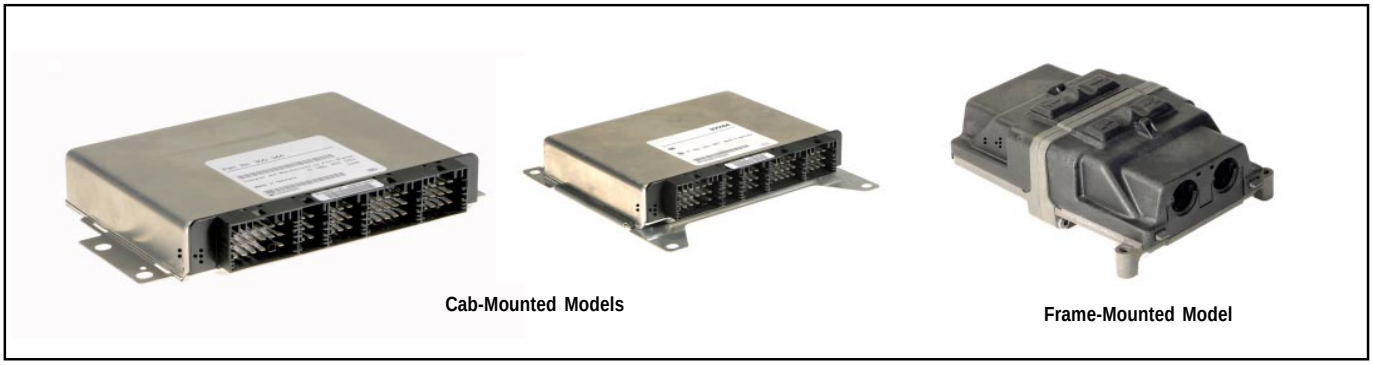


FIGURE 1 - Bendix® ABS Controller Assemblies

GEN 4™ AND GEN 5™ ABS INTRODUCTION

This manual describes both the cab mount and the frame mount versions of the Bendix® Gen 4™ and Gen 5™ Antilock Brake System/Automatic Traction Control (ABS/ATC) systems.

Both cab and frame mount versions are designed for:

- Tractors
- Trucks
- Buses and
- Motor Coaches and
- RVs.

This manual covers:

- ABS/ATC Operation
- System Components
- Service Procedures
- Diagnosis and
- Troubleshooting Procedures.

For information on disassembly, installation, and service of related axle and brake components, refer to their individual Bendix Service Manuals.

For assistance in your area call Bendix at 1-800-247-2725 or RoadRanger® at 1-800-826-4357.

These ABS controllers and systems were originally marketed by Eaton Corporation under the Eaton® brand name. For more information contact Bendix, your local authorized Bendix dealer, or RoadRanger®.

Document Revision Level

This document is subject to revision.
For updates, please visit www.bendix.com.

Table of Contents

ANTILOCK BRAKING SYSTEM (ABS)

ABS-controlled braking ensures optimum vehicle stability while minimizing the stopping distance. During vehicle operation, the ABS Electronic Control Unit (ECU) continuously monitors all wheel speed sensors. Data input from the wheel speed sensors allows the ECU to:

- Detect impending wheel lock.
- Maintain optimum wheel slip during braking.
- Maximize vehicle stability while maintaining braking effectiveness.

ABS Operation

The ABS controls braking by operating the Pressure Modulator Valves. The ECU makes a new assessment of conditions and updates the control signal to the pressure modulator valves at the rate of 100 times per second.

When inactive, the pressure modulator valves provide straight-through-passages for supply air to the brake chambers. During ABS operation (an ABS "event"), the control unit operates the valves to override the supply of air to the chambers. During an ABS release, supply air is held off while the chambers are vented to the atmosphere. In hold mode, supply air is held off and chamber air is held constant. When required, air is applied to the chamber at a controlled rate by modulating the hold side of the modulator valve.

The ABS system itself does not apply additional braking power. Rather, the purpose of ABS is to limit brake torque to prevent locking that results in loss of lateral stability and increased stopping distances. Cautious driving practices such as maintaining adequate distances from the vehicle ahead are still essential to safe vehicle operation.

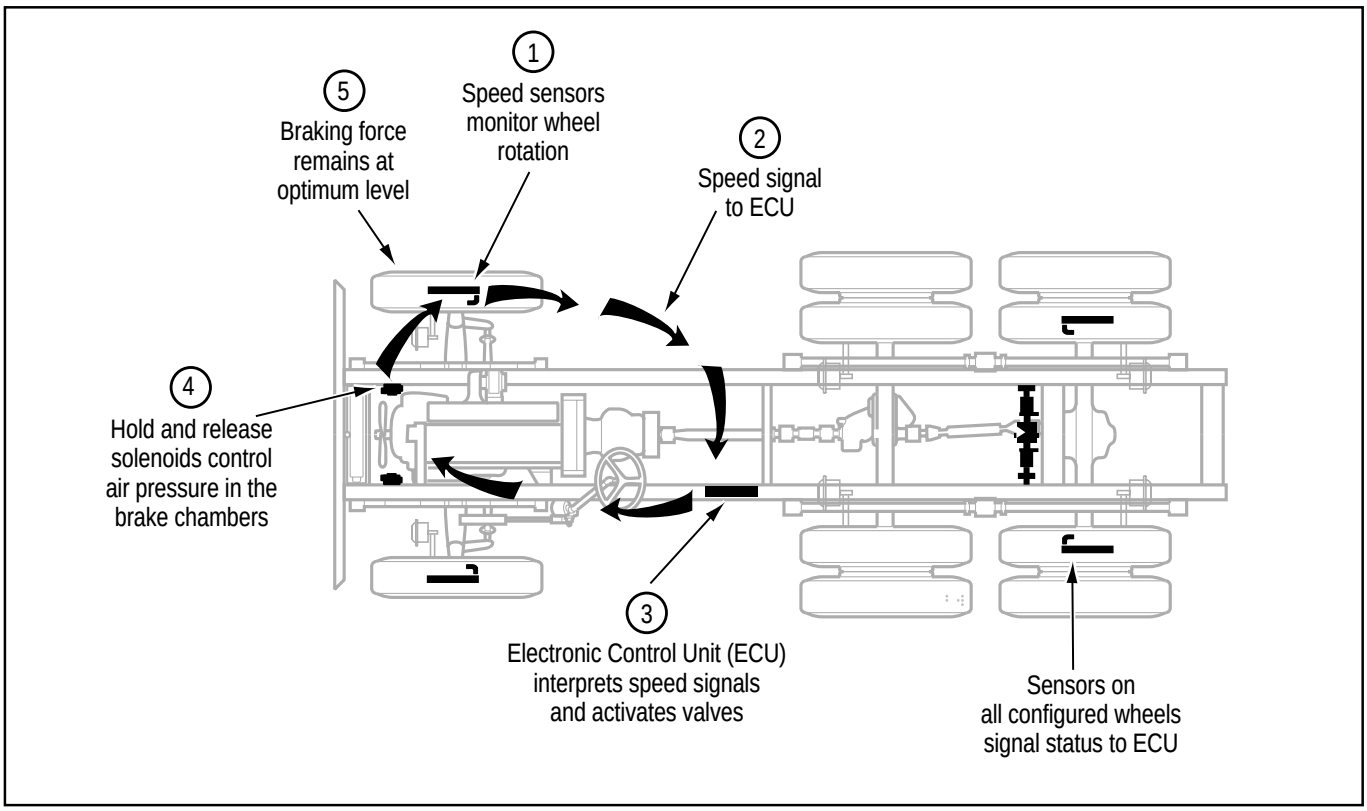


FIGURE 2 - Overview of ABS Operation

ABS Component Function

The ABS system operates as follows (see Figure 2).

1. Speed sensors on each wheel monitor wheel rotation.
2. Each speed sensor communicates wheel rotation pulses to the central Electronic Control Unit (ECU).
3. The ECU receives speed sensor input, interprets the signal pulses, and calculates speed and acceleration rates for the wheels and the vehicle.
4. Based on speed sensor input with the brakes applied, the ECU detects impending wheel lock and operates the ABS modulator valves as required for proper control. The modulator valves can be operated in either a release or a hold mode to regulate air pressure in the brake chambers.
5. Braking force is applied at a level which minimizes stopping distance while maintaining as much lateral stability as possible.

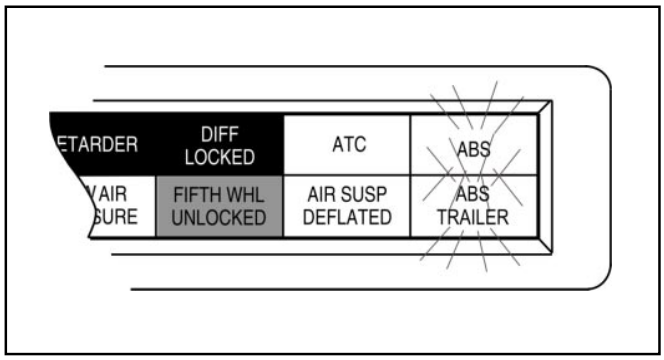


FIGURE 3 - ABS Indicator Lamps

ABS Indicator Lamp

This lamp is the primary indicator of the ABS status.

- The ABS lamp illuminates steadily for a two second bulb-check whenever the switched ignition is ON. The ABS lamp turns OFF after the bulb-check if there are no ABS malfunctions present.
- The ABS lamp flashes on and off continuously when the off-highway mode is selected. (Special option for military and off-highway vehicles.)
- If the Indicator Lamp remains ON, after the bulb-check, there is an ABS diagnostic trouble code that requires service.

NOTE: In the case of a speed sensor failure which has been corrected, the indicator lamp will remain on until sensor output has been verified by the control unit. In this case it is necessary to move the vehicle above 5 mph before the indicator lamp will turn off.

ABS Trailer Indicator Lamp

Tractor/Towing vehicles manufactured on or after March 1, 2001 are equipped with a cab mounted “ABS Trailer” indicator lamp.

When an ABS equipped trailer with Power Line Carrier (PLC) communications capability is connected to the tractor, the ABS Trailer indicator lamp will illuminate for a two second bulb check after the ignition is switched on. The ABS lamp turns OFF after the bulb-check if there are no ABS malfunctions present on the trailer ABS.

If the trailer is NOT equipped with ABS or ABS with PLC capability, the ABS trailer indicator lamp in the cab will not illuminate.

Automatic Traction Control (ATC) System

The ATC system is available on all Standard ABS ECU's. ATC is not available on Basic ECU's. It helps improve traction on slippery or unstable driving surfaces by preventing excessive wheel spin. ATC also enhances vehicle stability by prevention of power spin-out.

ATC requires:

1. ATC valve - Either a stand alone valve or a Rear Axle Valve Assembly with integral ATC solenoid may be used.
2. SAE J1922 or J1939 engine interface (the ABS ECU serial data interface must match the engine controller interface).
3. Brake Light Switch input.
4. ATC Indicator Lamp.

The Electronic Control Unit (ECU) must be configured for ATC operation either by using the diagnostic switch, an MPSI ProLink® hand-held tester or Eaton's ServiceRanger PC software.

ATC Operation

During periods of wheel slip, the Electronic Control Unit enters an Automatic Traction Control mode. There are various modes of Automatic Traction Control.

System operation:

- At speeds above 25 mph, the engine is throttled back via the SAE J1922 or SAE J1939 data link to control spin out.
- At speeds below 25 mph, both engine control and differential brake control are activated as required to control wheel slip. Once triggered, differential braking mode remains active regardless of vehicle speed.
- An optional mud and snow switch allows greater wheel spin (more torque) when activated. It is intended for adverse conditions, usually off-highway. Except for special cases, the switch is programmed for momentary operation. ATC reverts to normal operation when the switch is cycled a second time and whenever the system goes through a power-up cycle.

Component Function

When brake control is utilized, the ATC valve is activated, diverting supply tank air to the Modulator Valves on the drive axle(s). The Electronic Control Unit then activates the appropriate solenoids in order to apply a brake force to the spinning wheel. The Automatic Traction Control System cannot increase traction to a particular wheel; it can only utilize the available traction.

Thermal (Brake Heat) Protection

To prevent excessive brake and drum temperature resulting from brake activity, ATC incorporates a brake temperature estimation algorithm to determine when differential braking mode should be suspended. The differential braking function is re-enabled after a cool-down period.

ATC Indicator Lamp

The ATC indicator lamp operates when a vehicle is equipped with the optional Automatic Traction System.

- Gen 4™ ABS – Lights at key-ON and remains lit with ATC inactive until the driver presses the brake pedal.
- Gen 5™ ABS – Lights at key-ON and turns off after a 2 second lamp check. ATC is active after the lamp check.
- Flashes *rapidly* to indicate that ATC is active.
- Flashes *slowly* when the "mud-and-snow" mode is selected and then flashes more *rapidly* when the automatic traction control system operates.
- Remains ON if an engine data link failure occurs.

NOTE: Some non-ATC equipped vehicles have an ATC lamp that is labeled as a spin light. It indicates when a low traction condition has been encountered. No control action is taken.

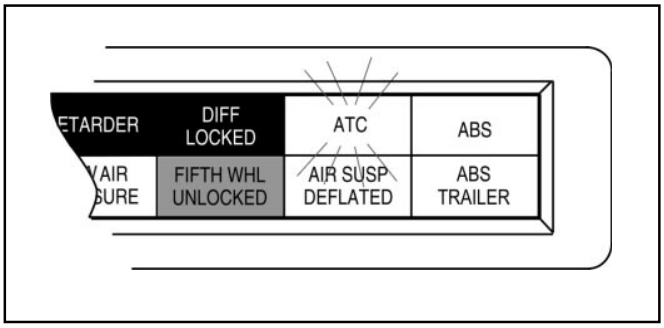


FIGURE 4 - ATC Indicator Lamp

Component Overview

Bendix ABS components include:

- **Electronic Control Unit (ECU):** The ECU monitors and controls the ABS. It also diagnoses ABS malfunctions and stores specific diagnostic trouble codes.
- **Pressure Modulator Valve (PMV):** This component regulates brake chamber air pressure. It houses the hold and release solenoids. A modulator valve is located near each brake chamber or pair of brake chambers that make up an ABS controlled wheel site.
- **Rear Axle Valve Assembly:** An assembly made up of two pressure modulator valves and a relay valve.
- **Wheel End Speed Sensor:** Single point variable reluctance (magnetic) sensor that generates an alternating voltage signal in response to the movement of teeth on a tone wheel.
- **ABS Lamp** *(Yellow)***:** This indicator lamp, located on the driver instrument panel, warns the driver of ABS malfunctions. It is also capable of blinking diagnostic fault codes when the ECU is in the self-diagnostic mode.
- **In-Cab ABS Trailer Lamp:** This indicator lamp, located on the driver instrument panel, warns the driver of trailer ABS malfunctions. It is not capable of blinking diagnostic trouble codes.
- **ATC Valve:** The traction control valve applies full system pressure to the relay valve during traction control operation to provide differential (side to side) braking at controlled drive axles.
- **ATC Lamp:** This indicator lamp, located on the driver instrument panel, lights to indicate loss of traction which is being managed by the Automatic Traction Control System.
- **Relay/Breaker Panel:** The OEM provides two circuit breakers and either one or two relays as part of the ABS. One relay is used for indicator lamp control. A second (optional) relay may be used to control a retarder and/or lockup torque converter.
- **Diagnostic Port Connector:** The diagnostic port connector is an industry standard connector that is used to connect to the J1587 diagnostic link. This connector also provides power and ground for diagnostic test equipment.

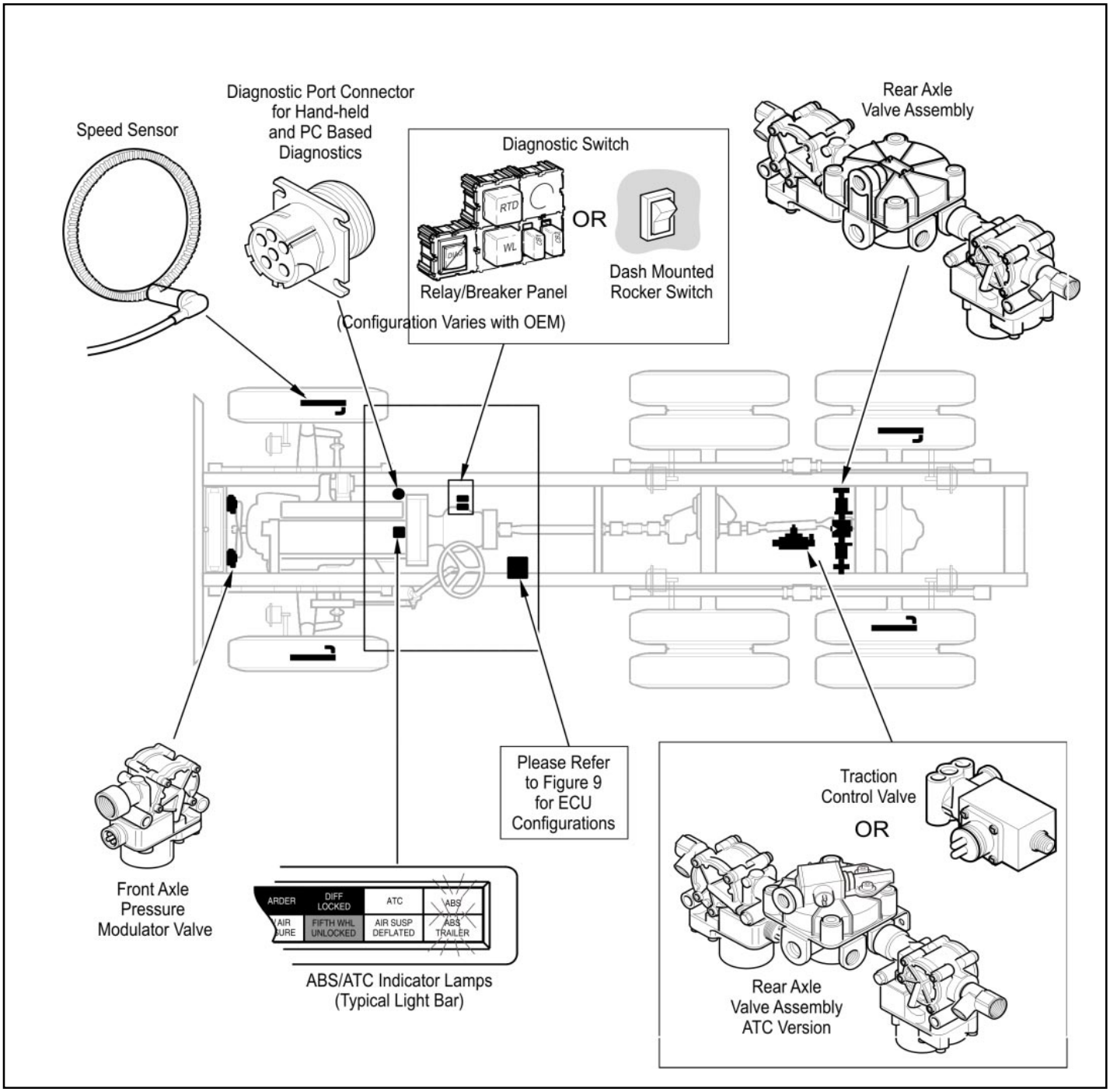


FIGURE 5 - ABS Components

Electronic Control Units (ECUs)

Identification

Frame mount ECUs are environmentally packaged versions of the related Gen 4™ & Gen 5™ ABS cab-mounted units (Standard, Basic). The circuitry and software is the same. Gen 5™ ABS units incorporate power line carrier (PLC) hardware. ECUs are available in 4 and 6-channel versions with either J1922 or J1939 data links. There is also a 24-volt version. Further service information is available on www.bendix.com.

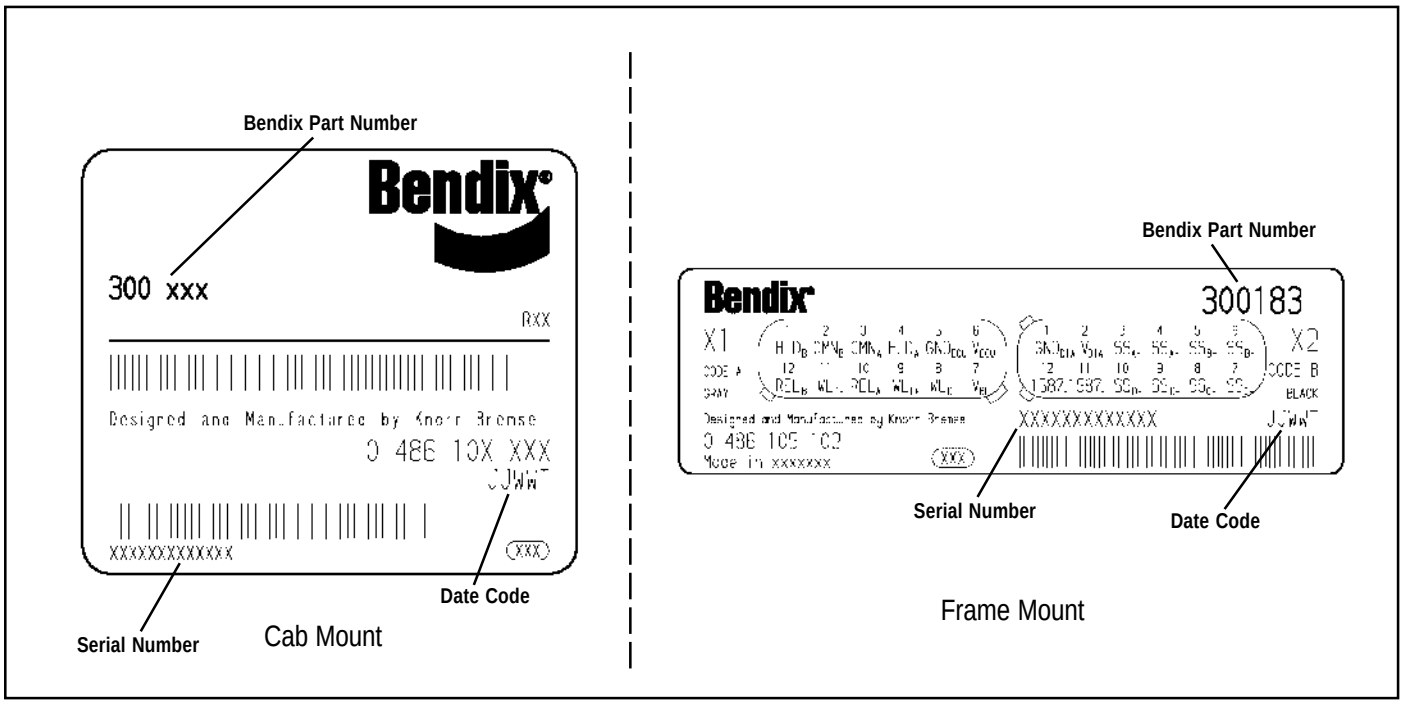
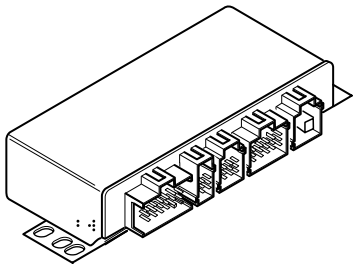
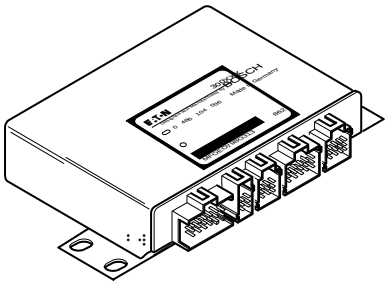


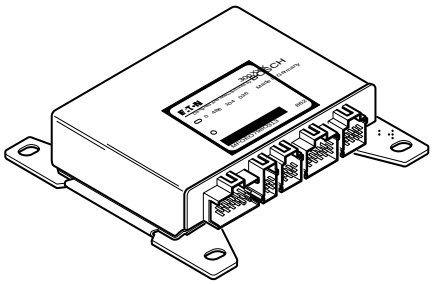
FIGURE 6 - Electronic Control Unit Identification Tags



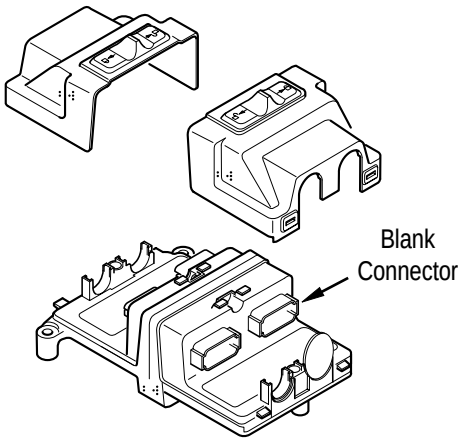
Gen 4™ & Gen 5™ ABS - Basic Cab Mount



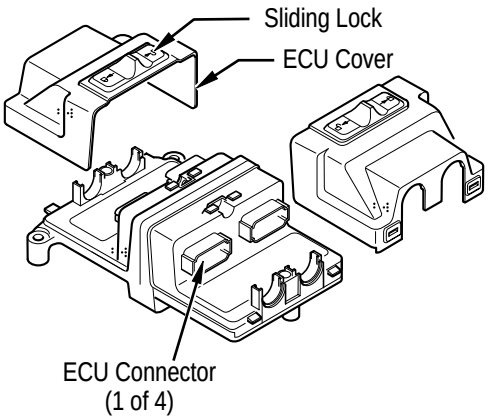
Gen 5™ ABS – Standard Cab Mount



Gen 4™ ABS – Standard Cab Mount



Gen 5™ ABS (PLC - Basic Frame Mount)



Gen 4™ & Gen 5™ ABS – Standard Frame Mount

FIGURE 7 - Available Bendix ABS Electronic Control Units

ABS Valves

The ABS modulator valve controls air pressure to individual brake assemblies. Depending on the particular ABS configuration, a system may utilize three, four or six modulator valves. See Figure 8.

Each modulator valve contains two air control solenoids, which act as pilots to the hold and release diaphragms. The hold solenoid blocks inlet air to brake chambers; the release solenoid removes pressure from the brake. The 3-pin threaded connector has pins for the hold and release solenoid and a third, common terminal.

Rear Axle Valve Assemblies

Rear Axle Valve Assemblies are available for some applications depending on OEM preferences. They are combinations of two modulator valves and a relay valve. The assemblies are available in 4.0 and 5.5 PSIG versions, with or without an integral ATC solenoid.

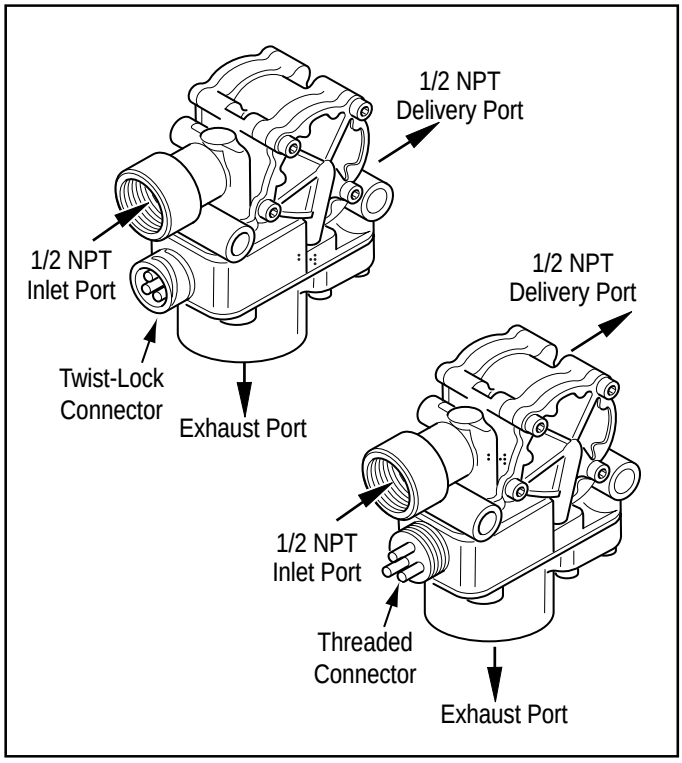


FIGURE 8 - Modulator Valve

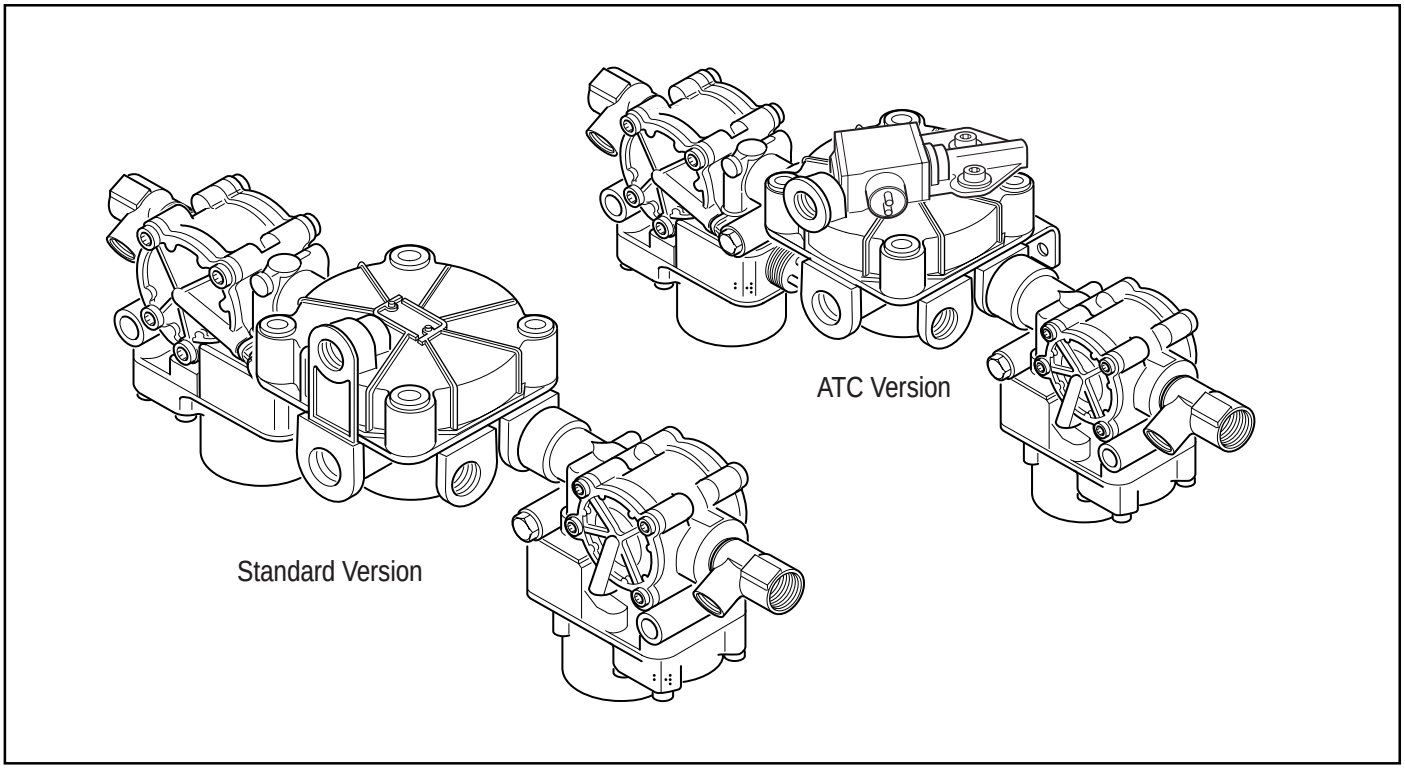


FIGURE 9 - Rear Axle Valve Assemblies, 4-Port ABS and ABS/ATC Versions Shown

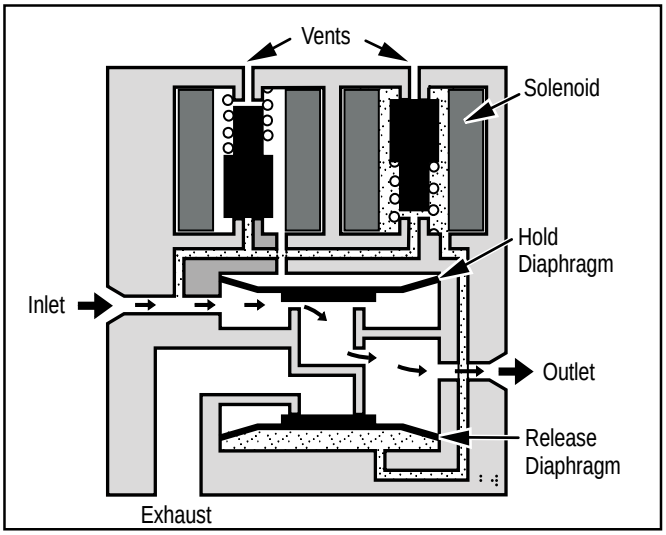


FIGURE 10 - Normal Apply and ABS/ATC Apply

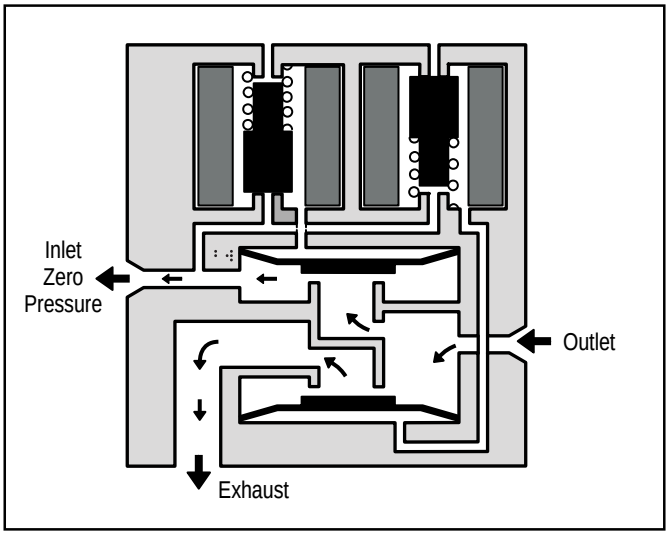


FIGURE 11 - Normal Release

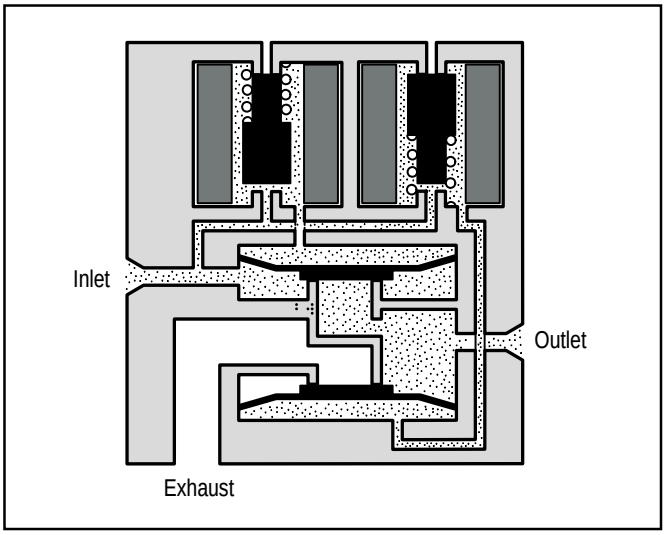


FIGURE 12 - ABS/ATC Hold

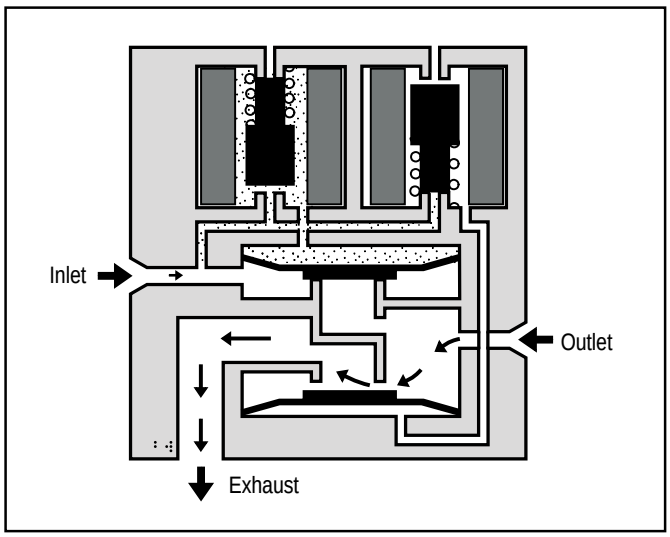


FIGURE 13 - ABS/ATC Release

Modulator Valve Operation Modes

1. **Apply**–Air flows straight through valve. Hold diaphragm is vented to allow air flow. Inlet pressure feeds behind release diaphragm to block the exhaust port. No solenoids are activated.
2. **Normal Release**–With quick release function, hold diaphragm is vented and there is no pressure at the inlet port. Air is allowed to flow from outlet to inlet. Since release diaphragm is not pressurized, air also flows out the exhaust port. No solenoids are activated.
3. **ABS/ATC Hold**–The hold solenoid is activated. Both diaphragms are pressurized. No air flows through the valve.
4. **ABS/ATC Release**–Both solenoids are activated. The hold diaphragm is pressurized, blocking the inlet air. The release diaphragm is vented, allowing air to flow from the outlet port back through the exhaust port.

Optional Front Axle Modules

An optional front axle module is available. It is an assembly of two modulator valves and a quick release valve. Three crack pressure settings are available:

- 0-1 PSIG
- 3-4 PSIG
- 6-8 PSIG.

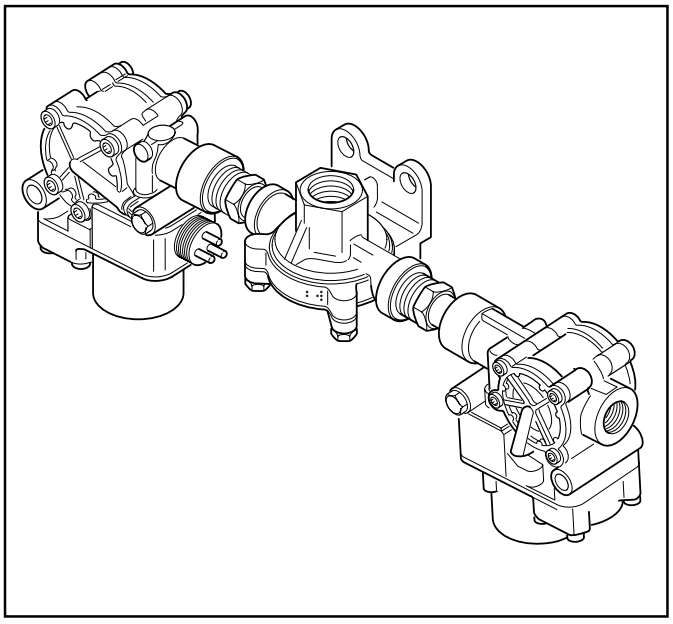


FIGURE 14 - Front Axle Module

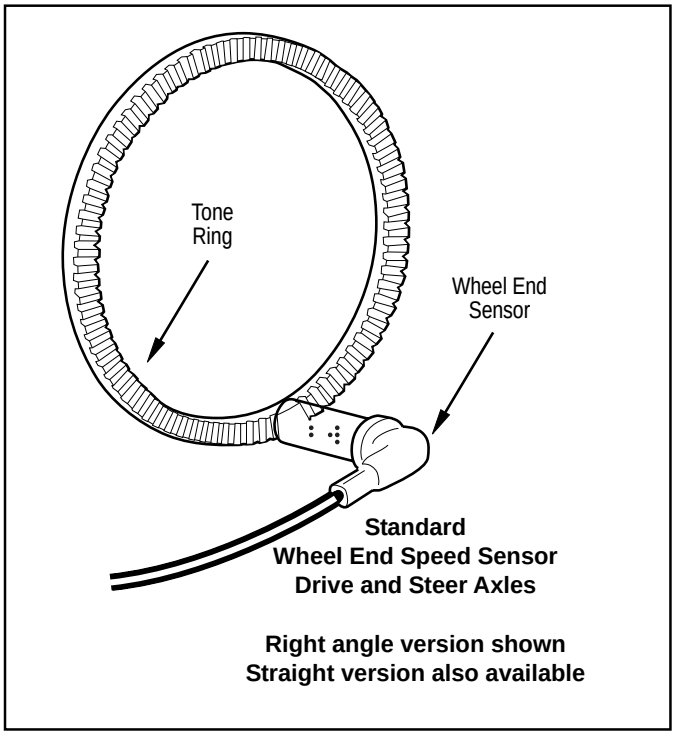


FIGURE 15 - Sensor Assembly

Speed Sensors

Each wheel of an axle under direct ABS control is monitored by a speed sensor. Speed sensors for drive axles and steer axles may be different styles and installed in different locations.

Wheel End Sensors

For most applications, Bendix ABS uses standard wheel end sensors (see figure 15). The front sensor is accessible on the inboard side of the steering knuckle. The rear drive axle sensor is accessible by removing the wheel and drum assembly.

Wheel-end sensors are conventional, single point, variable reluctance sensors. These are often referred to as "magnetic sensors" or "magnetic pickups." These sensors consist of a rod or pole piece surrounded by a coil of wire. A magnet is closely coupled to the pole piece and circulates a magnetic field through the coil. As the teeth of the tone ring rotate past the pole piece, the resistance (reluctance) to the magnetic field varies. The variable reluctance causes variations in the magnetic field which in turn induce a varying voltage in the coils which are wound around the pole piece.

Some general characteristics of variable reluctance, magnetic sensors are:

- The output voltage decreases as the air gap increases.
- The output voltage increases with the speed of the teeth past the pole piece.
- The output voltage waveform is independent of the direction of wheel rotation.

Wheel-End Sensors are protected with stainless steel metal sheaths. They are designed to fit within beryllium-copper friction sleeves which give them a self-adjustment feature.

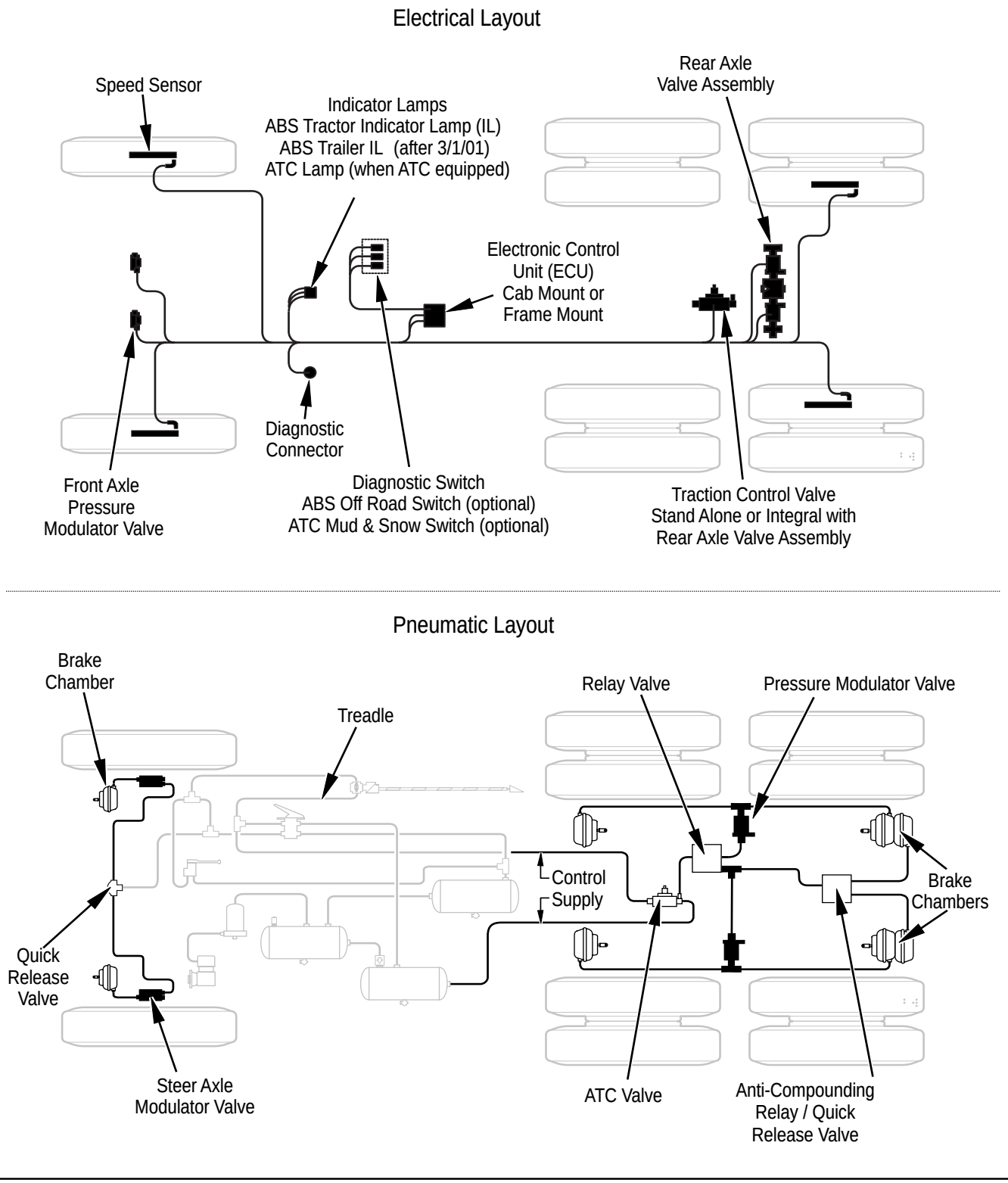


FIGURE 16 - Typical Electrical and Pneumatic Layouts

DIAGNOSTICS

An important feature of Bendix ABS is the system diagnostic capability. This section describes how to retrieve configuration information and error codes to troubleshoot ABS system diagnostic trouble codes. There are three ways to retrieve and display ABS configuration information and trouble codes:

- **ServiceRanger PC software:** Displays configuration information and diagnostic trouble codes on the PC monitor. Refer to the ServiceRanger PC software information later in this section.
- **ProLink hand-held tester:** Displays configuration information and diagnostic trouble codes on the hand-held tester display. Refer to the hand-held tester information later in this section.
- **Diagnostic switch:** Flashes configuration code and diagnostic trouble codes on the ABS indicator lamp. Refer to page 18 for operation of the diagnostic switch.

WARNING! PLEASE READ AND FOLLOW THESE INSTRUCTIONS TO AVOID PERSONAL INJURY OR DEATH:

When working on or around a vehicle, the following general precautions should be observed at all times.

1. **Park the vehicle on a level surface, apply the parking brakes, and always block the wheels. Always wear safety glasses.**
2. **Stop the engine and remove ignition key when working under or around the vehicle. When working in the engine compartment, the engine should be shut off and the ignition key should be removed. Where circumstances require that the engine be in operation, EXTREME CAUTION should be used to prevent personal injury resulting from contact with moving, rotating, leaking, heated or electrically charged components.**
3. **Do not attempt to install, remove, disassemble or assemble a component until you have read and thoroughly understand the recommended procedures. Use only the proper tools and observe all precautions pertaining to use of those tools.**
4. **If the work is being performed on the vehicle's air brake system, or any auxiliary pressurized air systems, make certain to drain the air pressure from all reservoirs before beginning ANY work on the vehicle. If the vehicle is equipped with an AD-IS™ air dryer system or a dryer reservoir module, be sure to drain the purge reservoir.**
5. **Following the vehicle manufacturer's recommended procedures, deactivate the electrical system in a manner that safely removes all electrical power from the vehicle.**
6. **Never exceed manufacturer's recommended pressures.**
7. **Never connect or disconnect a hose or line containing pressure; it may whip. Never remove a component or plug unless you are certain all system pressure has been depleted.**
8. **Use only genuine Bendix® replacement parts, components and kits. Replacement hardware, tubing, hose, fittings, etc. must be of equivalent size, type and strength as original equipment and be designed specifically for such applications and systems.**
9. **Components with stripped threads or damaged parts should be replaced rather than repaired. Do not attempt repairs requiring machining or welding unless specifically stated and approved by the vehicle and component manufacturer.**
10. **Prior to returning the vehicle to service, make certain all components and systems are restored to their proper operating condition.**
11. **For vehicles with Antilock Traction Control (ATC), the ATC function must be disabled (ATC indicator lamp should be ON) prior to performing any vehicle maintenance where one or more wheels on a drive axle are lifted off the ground and moving.**

Troubleshooting Procedures

Figure 17 shows an organized approach to troubleshooting ABS trouble codes. Follow the steps listed below to locate and correct ABS component and wiring problems.

1. Check that the ABS ECU configuration corresponds to the ABS components installed on the vehicle. Reconfigure the ECU if the configuration does not match the installed ABS components.
2. Access active diagnostic trouble code(s). Inactive (historical) diagnostic trouble codes are also reported and may provide additional information to aid in troubleshooting.
3. Look up the code description, the possible causes and the repair procedures provided in this section.
4. Perform the recommended repair procedures.
5. After the repairs are completed, clear all codes and check for any additional codes.

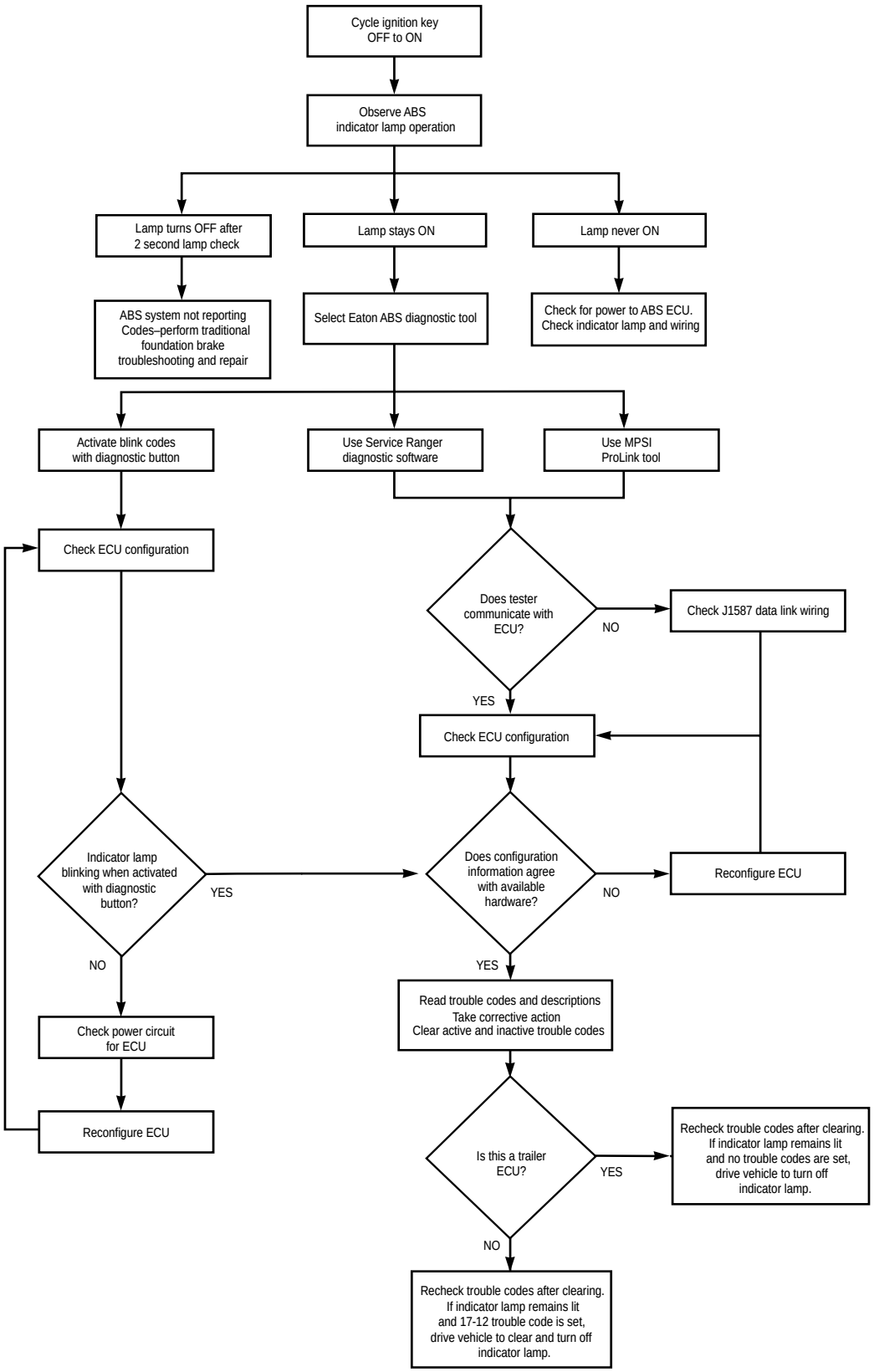


FIGURE 17 - Antilock Brake System Troubleshooting Chart

SYSTEM CONFIGURATIONS

Available Configurations

A wide variety of system configurations are available (refer to Figure 17). It is important to be able to read system configurations and to be able to properly reconfigure a system when necessary.

When to Configure

ECUs are factory configured for the most common requirements. Basic systems are setup for 4s-4m operation with retarder control via retarder relay. Standard systems are setup for 6s-4m operation with retarder control via engine data link. For applications other than these factory configurations (for example use of a retarder control relay, 4s-3m operation, 6s-6m operation or traction control), it is necessary to perform a configuration or "setup" process. This process sets up the ECU for the components that are installed so that proper control and fault tolerance will be implemented. The diagnostic switch, MPSI Pro-Link® tool or ServiceRanger PC software may be used to configure to a higher level (add components or functionality). If it is desired to move the configuration downward (fewer components than standard), the ProLink tool or ServiceRanger PC software must be used.

How to Configure

Use the "SYSTEM SETUP" menu with the MPSI ProLink® tool, the diagnostic switch (refer to page 25 for procedure) or ServiceRanger PC software. Use of the "SETUP" function will also clear inactive trouble codes from the system. However it is recommended that the "CLEAR TROUBLE CODES" function be used for clearing inactive codes.

Verification

It is important to verify that the intended configuration has been obtained. Refer to Figure 20 (page 17) for proper interpretation of configuration blink codes.

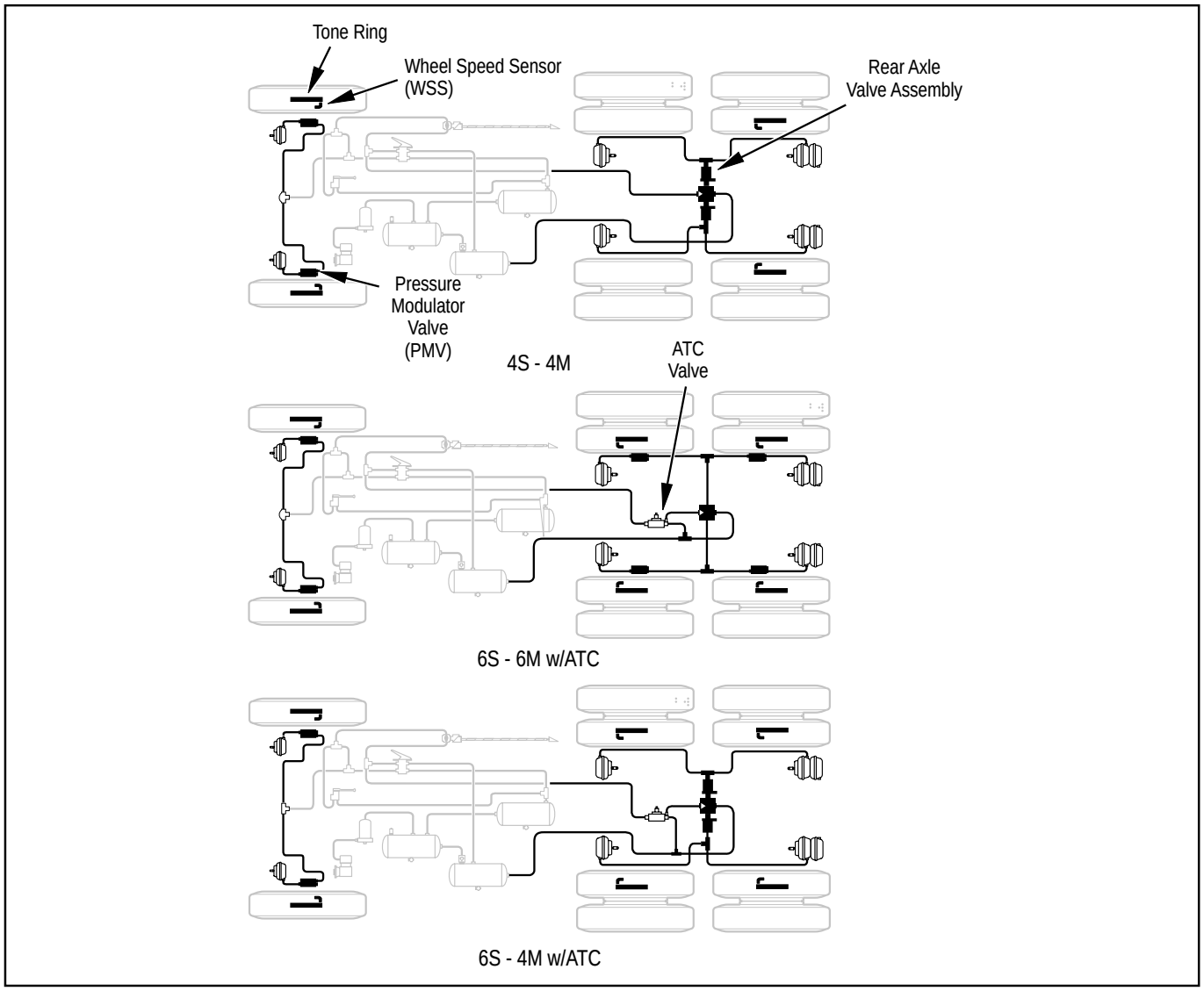


FIGURE 18 - Typical ABS Configurations

Test Equipment

Bendix recommends the use of the following products to troubleshoot the ABS system:

- A multimeter or digital volt-ohmmeter (DVOM).
- Eaton ServiceRanger PC software or an MPSI ProLink® hand-held tester.

Multimeter

A multimeter can be used to check:

- Speed sensor circuit resistance.
- PMV and ATC valve solenoid resistances.
- ABS power circuit voltages.
- Engine data link voltages.
- Retarder control relay.
- Wiring harness diagnostic trouble codes.

ServiceRanger PC Software

ServiceRanger PC software can be used to read and clear error codes and obtain a short description of failures. The software can initiate test sequences for controller outputs and can also read system data such as voltage at the ECU, wheel speeds and cutout speeds.

CAUTION: Eaton ServiceRanger PC software can activate output tests for all output devices. Since these tests can affect operation of the vehicle braking system, the ECU incorporates special safety protection. One axle must show zero speed or the test will be halted.

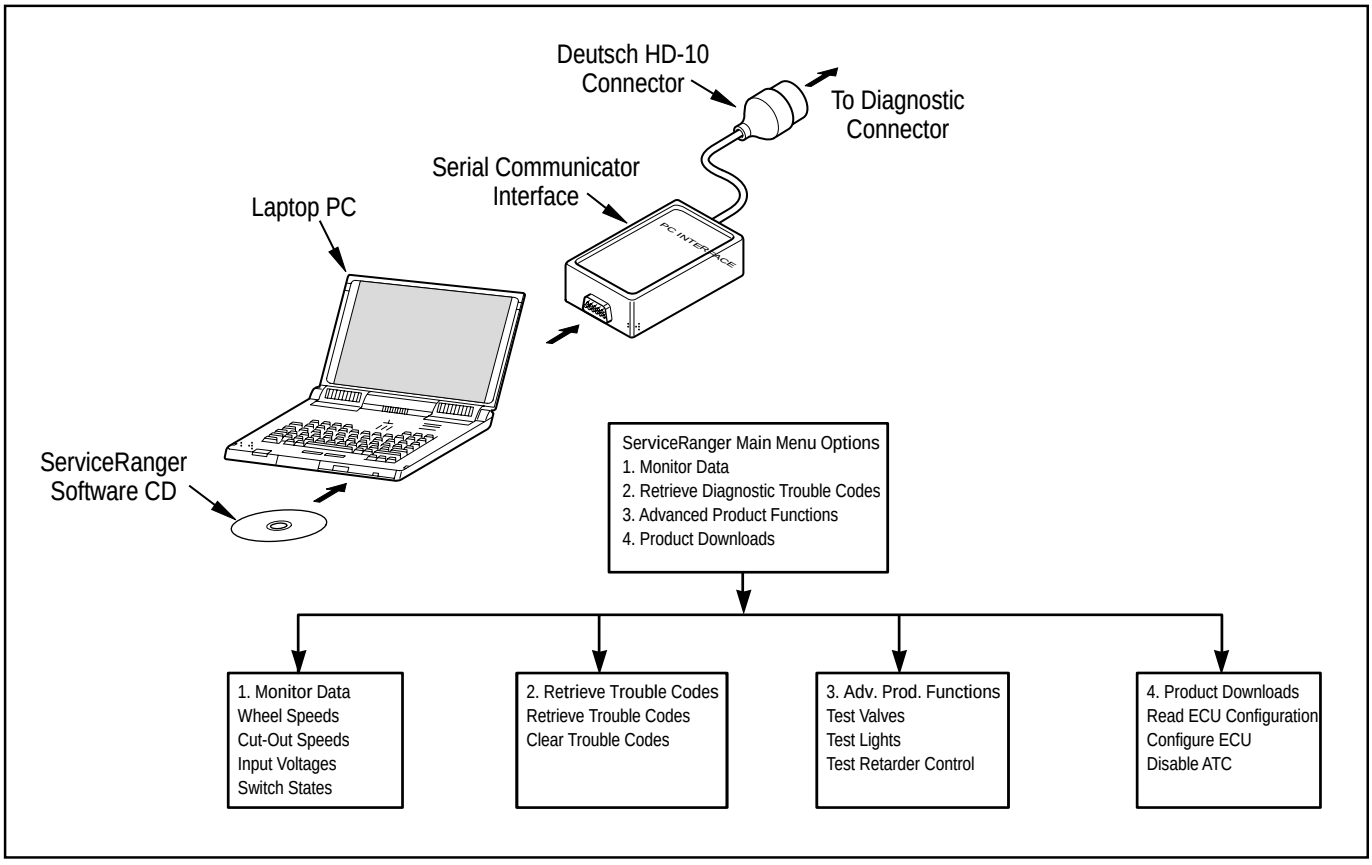


FIGURE 19 - ServiceRanger Menus & Hardware Setup

Hand-Held Tester

An MPSI ProLink® hand-held tester with Bendix proprietary cartridge can be used to read and clear error codes and obtain a short description of failures. The tester can initiate test sequences for controller outputs and can also read system data such as voltage at the ECU, wheels speeds and cutout speeds. A standard heavy duty truck cartridge may also be used, but cannot initiate test sequences.

CAUTION: The ProLink hand-held tester can activate output tests for all output devices. Since these tests can affect operation of the vehicle braking system, the ECU incorporates special safety protection. One axle must show zero speed or the test will be halted.

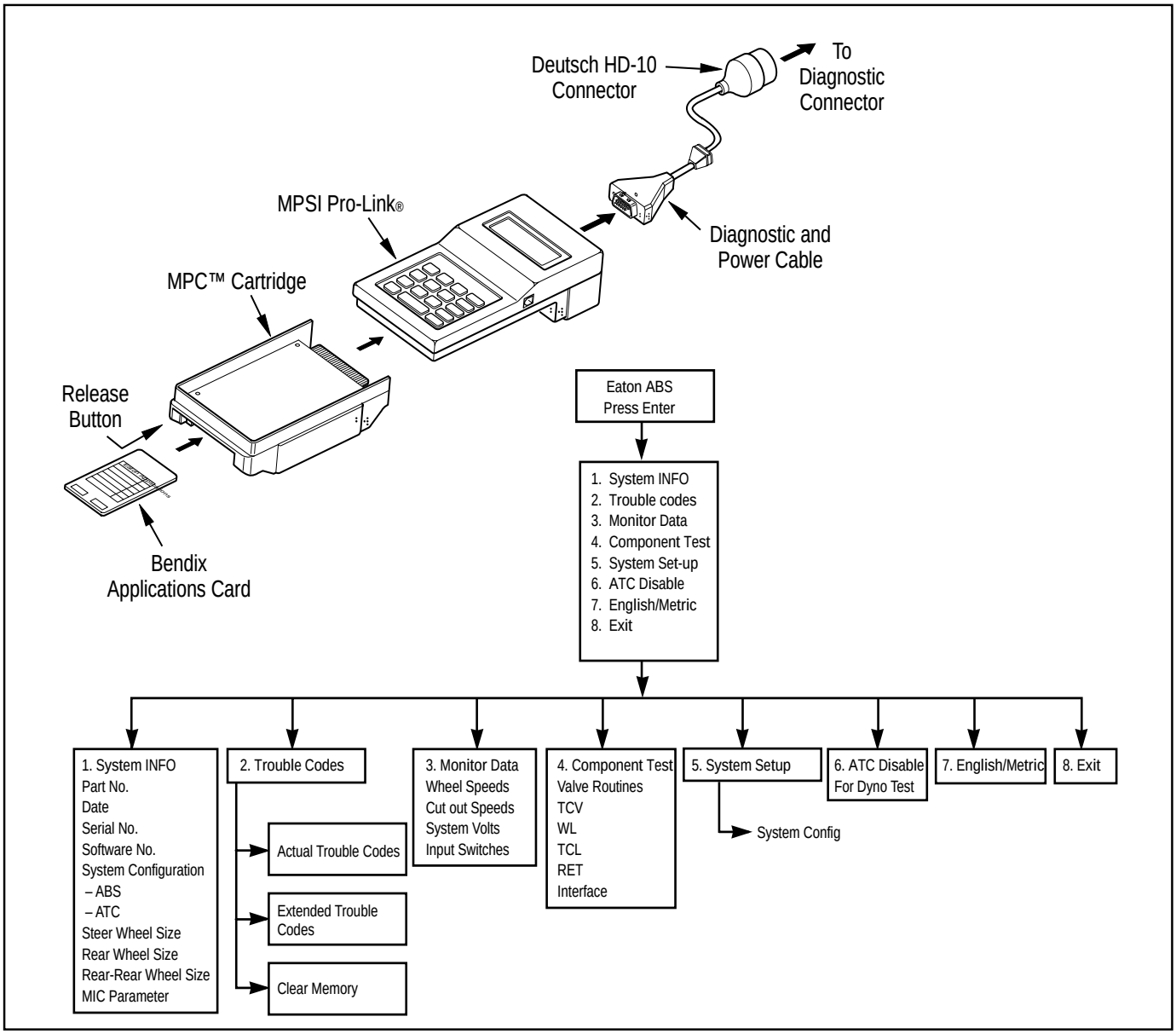


FIGURE 20 - Hand-Held Tester Menus and Set-Up

Diagnostic Switch

Blink Codes – System Configuration and System Faults.

By properly actuating the ABS diagnostic button, configuration codes and diagnostic trouble codes can be retrieved as blinked sequences on the ABS indicator lamp. Configuration codes are sequences of four blinked digits while diagnostic trouble codes appear as two blinked numbers. Refer to the charts beginning on page 19 for a description of these codes. To perform any of the activities listed below, simply follow the steps as given. If you make a mistake during one of the steps, stop and start over at the beginning of the procedure.

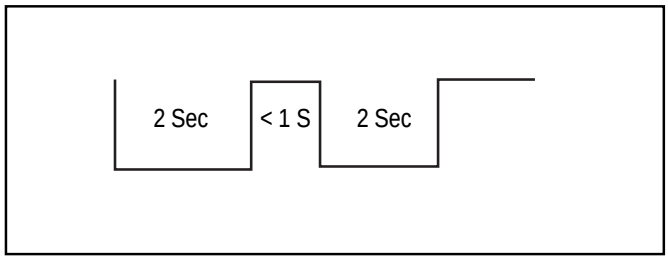
All blink codes are displayed by the ABS indicator lamp only. The ATC lamp does not display blink codes.

Note: Before attempting any repairs:

1. Retrieve the configuration codes and diagnostic trouble codes (write them down).
2. Reconfigure the ECU if the configuration does not agree with the installed hardware. The ECU cannot be configured downward (components removed) with the diagnostic button. For example, a 6S-4M cannot be configured to 4S-4M. Downward configurations require the use of a ProLink tool or ServiceRanger software.
3. If the configuration is correct, clear the diagnostic trouble codes. The process for clearing the trouble codes and reconfiguring the ECU is the same when using the diagnostic button.
4. Once again retrieve the diagnostic trouble codes. Only active codes will now be displayed.

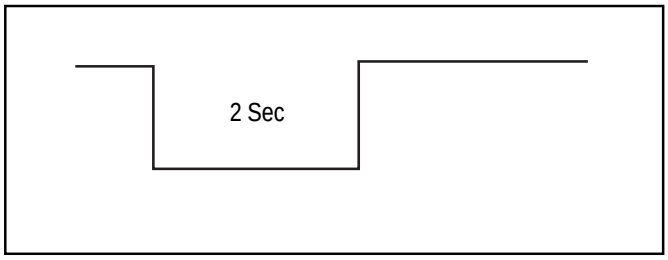
Reading Configuration Codes

- Turn the ignition key to “ON.”
- Press and hold the diagnostic button for two seconds and release.
- Without pause, press the diagnostic button a 2nd time for two seconds and release.
- Four-digit configuration code is retrieved and displayed.



Retrieving Diagnostic Trouble Codes

- Turn the ignition key to “ON.”
- If vehicle is equipped with ATC, apply and release brakes once before proceeding.
- Press and hold the diagnostic button for two seconds and release.
- Two-number blink codes are retrieved and displayed.



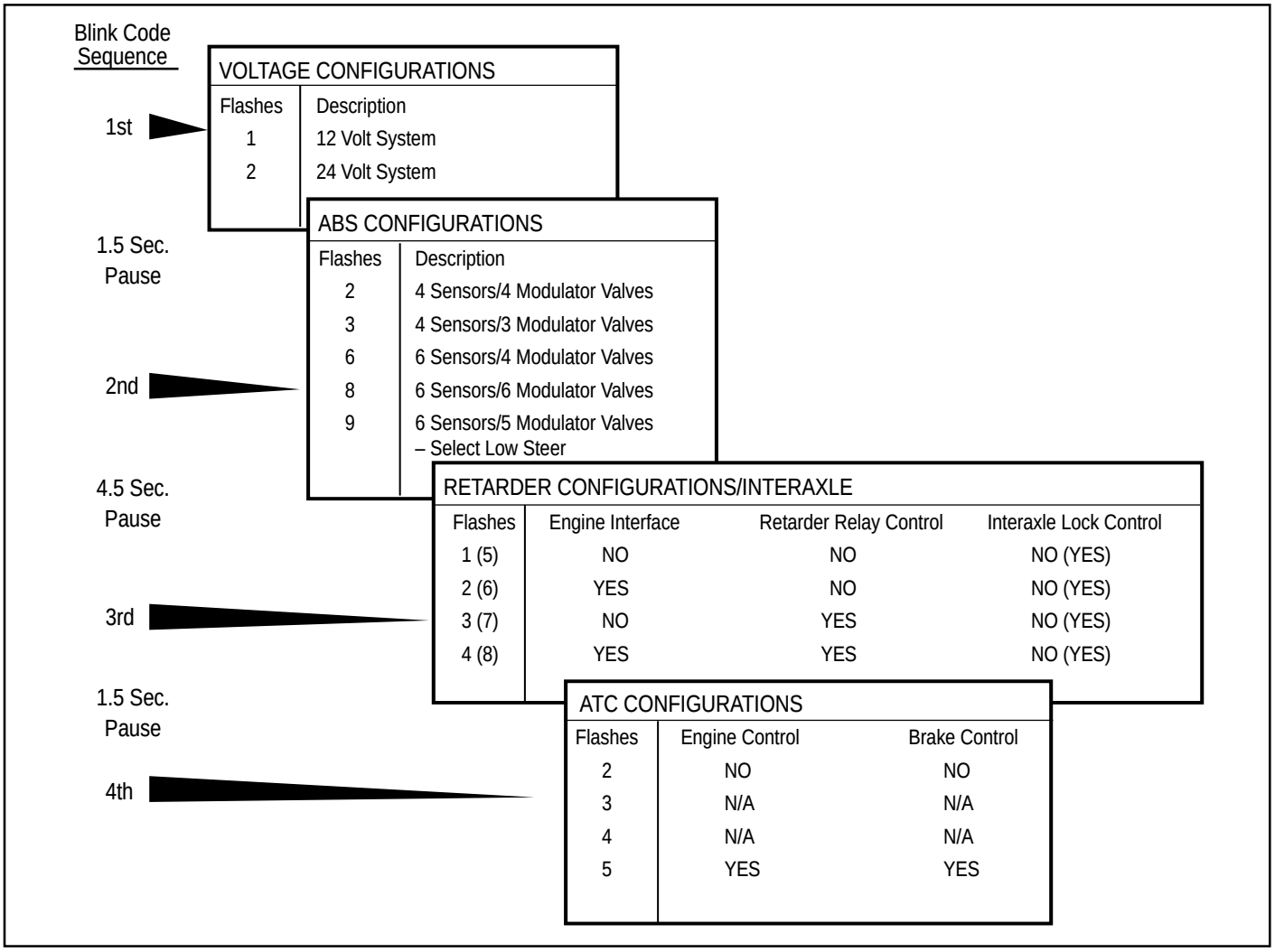
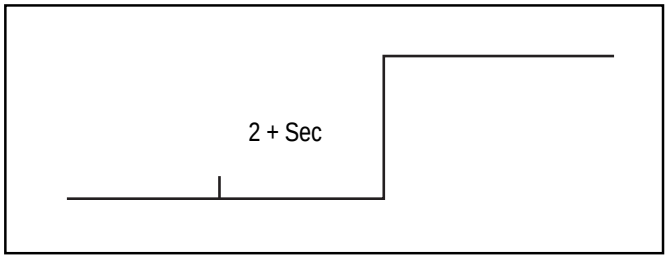


FIGURE 21 - Reading ABS Configuration Codes

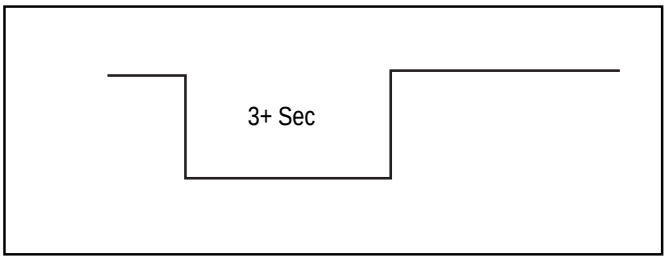
Clearing Diagnostic Trouble Codes and/or System Configuration

- With the ignition "OFF" press and hold the diagnostic button.
- Turn the ignition key to "ON" while pressing the diagnostic button.
- Wait two seconds and release the diagnostic button.
- Press and release the brake pedal.
- ECU is reconfigured to match connected components and diagnostic trouble codes are cleared.
- Repeat the "Retrieving Diagnostic Trouble Codes" procedure to verify that the trouble codes are cleared.



Disabling ATC for Dyno Testing

- Turn the ignition key to "ON."
- Press and hold the diagnostic button for at least 3 seconds and release.
- ATC light turns "ON" and ABS light blinks 17 • 8 indicating ATC is disabled.
- At the next ignition cycle ATC will be reactivated.



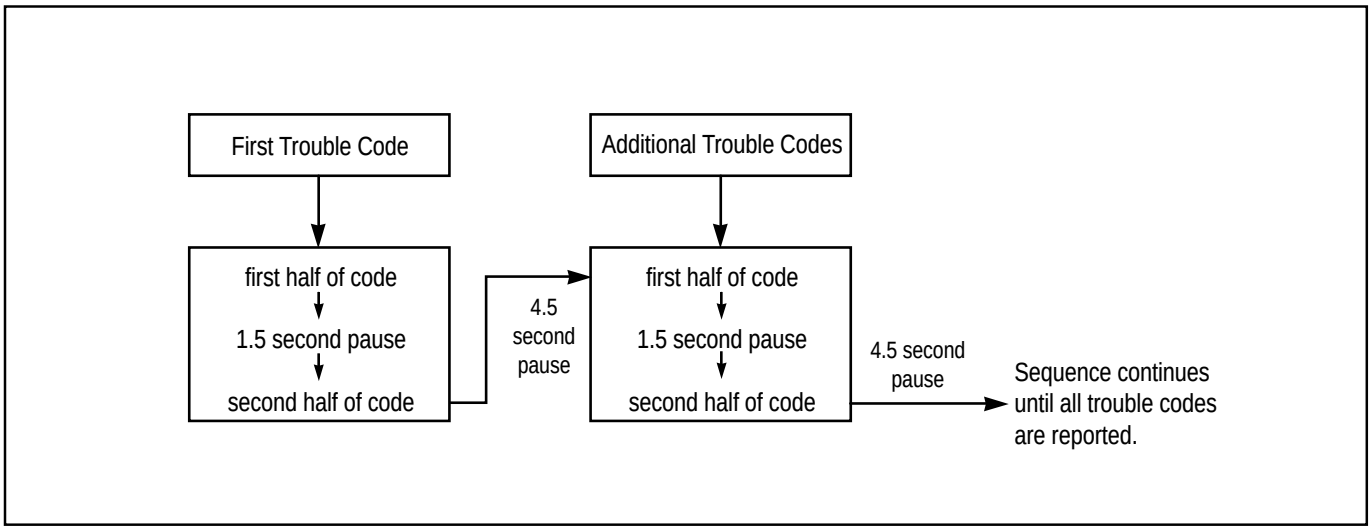


FIGURE 22 - Typical Blink Code Report

Blink Codes		MID 136 SID/FMI	Description	Location
1st.	2nd.			
1	1	–/–	No Trouble Found	
2	1	001/000	Sensor air gap too large.	Left Steer Sensor
2	2	001/008	Air gap too large or sensor shorted.	
2	3	001/010	Speed Sensor signal is noisy.	
2	4	001/008	Wheel locked too long during an ABS cycle.	
2	5	001/008	High deceleration rate at wheel site or sensor shorted.	
2	6	001/012	Sensor shorted low or high or sensor open.	
2	7	001/012	Internal error at the sensor port of the ECU.	
2	8	001/002	Sensor in the wrong location for the system configuration.	
3	1	002/000	Sensor air gap too large.	Right Steer Sensor
3	2	002/008	Air gap too large or sensor shorted.	
3	3	002/010	Speed Sensor signal is noisy.	
3	4	002/008	Wheel locked too long during an ABS cycle.	
3	5	002/008	High deceleration rate at wheel site or sensor shorted.	
3	6	002/012	Sensor shorted low or high or sensor open.	
3	7	002/012	Internal error at the sensor port of the ECU.	
3	8	002/002	Sensor in the wrong location for the system configuration.	
4	1	003/000	Sensor air gap too large.	Left Rear Sensor.
4	2	003/008	Air gap too large or sensor shorted.	
4	3	003/010	Speed Sensor signal is noisy.	
4	4	003/008	Wheel locked too long during an ABS cycle.	
4	5	003/008	High deceleration rate at wheel site or sensor shorted.	
4	6	003/012	Sensor shorted low or high or sensor open.	
4	7	003/012	Internal error at the sensor port of the ECU.	
4	8	003/002	Sensor in the wrong location for the system configuration.	
5	1	004/000	Sensor air gap too large.	Right Rear Sensor.
5	2	004/008	Air gap too large or sensor shorted.	
5	3	004/010	Speed Sensor signal is noisy.	
5	4	004/008	Wheel locked for too long during an ABS cycle.	
5	5	004/008	High deceleration rate at a wheel site or sensor shorted.	
5	6	004/012	Sensor shorted low or high or sensor open.	
5	7	004/012	Internal error at the sensor port of the ECU.	
5	8	004/002	Sensor in the wrong location for the system configuration.	

Blink Codes		MID 136 SID/FMI	Description	Location
1st.	2nd.			
6	1	005/000	Sensor air gap too large.	Left Rear Sensor.
6	2	005/008	Air gap too large or sensor shorted.	
6	3	005/010	Speed Sensor signal is noisy.	
6	4	005/008	Wheel locked for too long during an ABS cycle.	
6	5	005/008	High deceleration rate at wheel site or sensor shorted.	Left Rear Sensor.
6	6	005/012	Sensor shorted low or high or sensor open.	(continued).
6	7	005/012	Internal error at the sensor port of the ECU.	
6	8	005/002	Sensor in the wrong location for the system configuration.	
7	1	006/000	Sensor air gap too large.	Right Rear Sensor.
7	2	006/008	Air gap too large or sensor shorted.	
7	3	006/010	Speed Sensor signal is noisy.	
7	4	006/008	Wheel locked too long during an ABS cycle.	
7	5	006/008	High deceleration rate at wheel site or sensor shorted.	
7	6	006/012	Sensor shorted low or high or sensor open.	
7	7	006/012	Internal error at the sensor port of the ECU.	
7	8	006/002	Sensor in the wrong location for the system configuration.	
8	1	007/003	Short circuit from the release solenoid to voltage.	Left Steer Axle PMV.
8	2	007/004	Short circuit from the release solenoid to ground.	
8	3	007/005	Open circuit at the release solenoid.	
8	4	007/005	Open circuit on the common line to the valve.	
8	5	007/003	Short circuit from the hold solenoid to voltage.	
8	6	007/004	Short circuit from the hold solenoid to ground.	
8	7	007/005	Open circuit at the hold solenoid.	
8	8	007/002	System configuration is incorrect.	
8	10	151/014	Inter-axle differential control circuit shorted high.	IAD Circuit.
8	10	151/014	Inter-axle differential control circuit shorted low or open.	
9	1	008/003	Short circuit from the release solenoid to voltage.	Right Steer Axle PMV.
9	2	008/004	Short circuit from the release solenoid to ground.	
9	3	008/005	Open circuit at the release solenoid.	
9	4	008/005	Open circuit on the common line to the valve.	
9	5	008/003	Short circuit from the hold solenoid to voltage.	
9	6	008/004	Short circuit from the hold solenoid to ground.	
9	7	008/005	Open circuit at the hold solenoid.	
9	8	008/002	System configuration is incorrect.	

Blink Codes		MID 136 SID/FMI	Description	Location
1st.	2nd.			
10	1	009/003	Short circuit from the release solenoid to voltage.	Left Rear Axle PMV.
10	2	009/004	Short circuit from the release solenoid to ground.	
10	3	009/005	Open circuit at the release solenoid.	
10	4	009/005	Open circuit on the common line to the valve.	
10	5	009/003	Short circuit from the hold solenoid to voltage.	
10	6	009/004	Short circuit from the hold solenoid to ground.	
10	7	009/005	Open circuit at the hold solenoid.	Left Rear Axle PMV (cont.).
10	8	009/002	System configuration is incorrect.	
10 or 11	9	014/003	Common side of valves – stray voltage detected.	PMV Commons.
10 or 11	10	014/003	Common side of valves shorted high.	
10 or 11	11	014/004	Common side of the valves shorted to ground.	
11	1	010/003	Short circuit from the release solenoid to voltage.	Right Rear Axle PMV.
11	2	010/004	Short circuit from the release solenoid to ground.	
11	3	010/005	Open circuit at the release solenoid.	
11	4	010/005	Open circuit on the common line to the valve.	
11	5	010/003	Short circuit from the hold solenoid to voltage.	
11	6	010/004	Short circuit from the hold solenoid to ground.	
11	7	010/005	Open circuit at the hold solenoid.	
11	8	010/002	System configuration is incorrect.	
12	1	011/003	Short circuit from the release solenoid to voltage	Left Rear Axle PMV.
12	2	011/004	Short circuit from the release solenoid to ground.	
12	3	011/005	Open circuit at the release solenoid.	
12	4	011/005	Open circuit on the common line to the valve.	
12	5	011/003	Short circuit from the hold solenoid to voltage.	
12	6	011/004	Short circuit from the hold solenoid to ground.	
12	7	011/005	Open circuit at the hold solenoid.	
12	8	011/002	System configuration is incorrect.	
13	1	012/003	Short circuit from the release solenoid to voltage.	Right Rear Axle PMV.
13	2	012/004	Short circuit from the release solenoid to ground.	
13	3	012/005	Open circuit at the release solenoid.	
13	4	012/005	Open circuit on the common line to the valve.	
13	5	012/003	Short circuit from the hold solenoid to voltage.	
13	6	012/004	Short circuit from the hold solenoid to ground.	
13	7	012/005	Open circuit at the hold solenoid.	
13	8	012/002	System configuration is incorrect.	

Blink Codes		MID 136 SID/FMI	Description	Location
1st.	2nd.			
14	**5**	018/003	Solenoid in ATC valve shorted high.	ATC Valve.
14	**6**	018/004	Solenoid in ATC valve shorted to ground.	
14	**7**	018/005	ATC valve open circuit.	
14	**8**	018/002	ATC valve found when it should not be present.	
14	**12**	249/002 or 231/002	Time-out or no connection to engine link (J1922/1939).	Data Link.
15	**1**	254/012	ECU internal trouble code.	ECU.
15	**2**	253/012	ECU internal trouble code.	
15	**3**	253/013	ECU internal trouble code.	
15	**4**	253/012	ECU internal trouble code.	ECU (cont.).
15	**5**	254/002	ECU internal trouble code.	
15	**6**	254/002	ECU internal trouble code.	
15	**7**	254/002	ECU internal trouble code.	
15	**8**	253/013	ECU internal trouble code.	
15	**9**	231/012	ECU internal trouble code.	
15	**10**	254/012	ECU internal trouble code.	
15	**11**	254/012	ECU internal trouble code.	
16	**1 or 5**	251/004	Excessive voltage on PMV Power.	Power Circuits.
16	**2 or 6**	251/003	Low voltage found on PMV Power.	
16	**3 or 7**	251/005	No voltage found on PMV Power.	
16	**4 or 8**	251/005	Open circuit found on PMV Ground.	
16	**9**	251/004	Excessive voltage found on ECU Power.	
16	**10**	251/003	Low voltage found on ECU Power.	
16	**11**	251/002	Voltage difference between PMV Power inputs is too high.	
17	**1**	013/003	Retarder control relay shorted high or open circuit.	
17	**2**	013/004	Retarder control relay shorted to ground.	
17	**3**	249/002 or 231/002	J1922/1939 date link not functioning.	
17	**4**	249/002 or 231/002	J1922/1939 date link time out.	
17	**5**	253/013	Tire size, front to rear out of range.	
17	**6**	253/013	Tire size out of range or parameter fault.	
17	**7**	—	Brake light switch not pushed at this power cycle.	
17	**8**	—	ATC system is disabled for dynamometer test.	
17	**10**	023/014	Indicator lamp circuit is faulty.	
17	**12**	151/014	Sensor memory bit set, (A sensor trouble code has occurred, the ECU must read wheel speeds on all wheels to clear this trouble code.)	

Speed Sensor Troubleshooting

Follow the steps listed below to locate and correct sensor related ABS trouble codes.

1. Access active trouble code(s) using either the Blink Code procedure, with ServiceRanger or the Hand-held Tester procedure.
2. Lookup the code description, the possible causes and the repair procedures provided in this section.
3. Perform the recommended repair procedures.
4. After the repairs are completed, clear all codes and check for any additional codes.
5. If a sensor related trouble code has occurred, a code 17•12 will remain in the system until the vehicle has been driven.

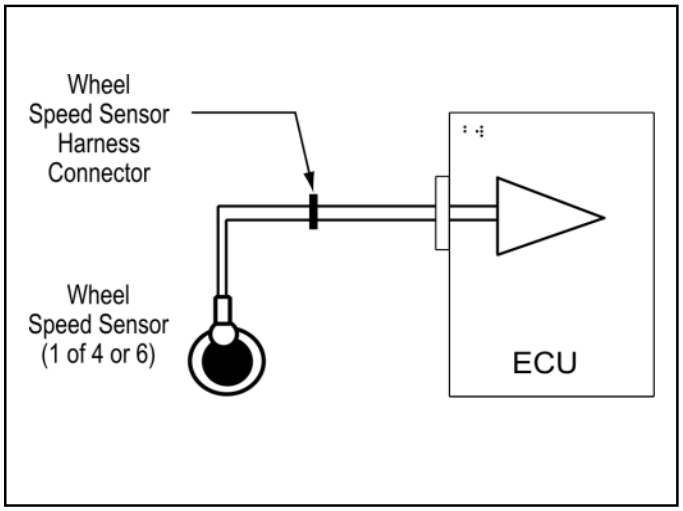
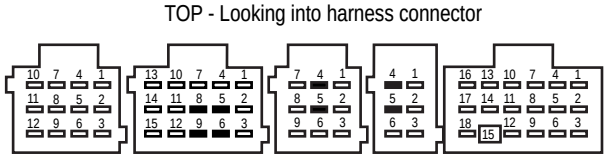
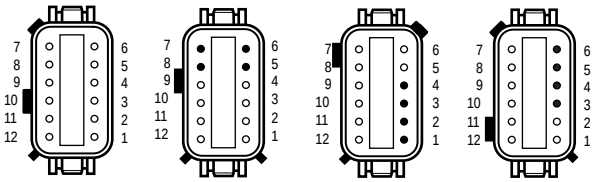


FIGURE 23 - Typical Wheel Speed Sensor Circuit





Harness Connector	PIN	Circuit Description
B (6-Way)	4	Speed Sensor (+) Left Steer
	5	Speed Sensor (-) Left Steer
C (9-Way)	4	Speed Sensor (+) Right Steer
	5	Speed Sensor (-) Right Steer
D (15-Way)	5	Speed Sensor (+) Left Rear
	6	Speed Sensor (-) Left Rear
	8	Speed Sensor (+) Right Rear
	9	Speed Sensor (-) Right Rear
E (12-Way) 6-channel Only	5	Speed Sensor (+) Left Rear Rear*
	6	Speed Sensor (-) Left Rear Rear*
	8	Speed Sensor (+) Right Rear Rear*
	9	Speed Sensor (-) Right Rear Rear*

*Not Used On Basic System

Harness Connector	PIN	Circuit Description
X2 (Black)	5	Speed Sensor (-) Right Steer
	6	Speed Sensor (+) Right Steer
	7	Speed Sensor (-) Left Steer
	8	Speed Sensor (+) Left Steer
X3 (Green)	1	Speed Sensor (-) Left Rear
	2	Speed Sensor (+) Left Rear
	3	Speed Sensor (-) Right Rear
	4	Speed Sensor (+) Right Rear
X4 (Brown) 6-channel Only	3	Speed Sensor (-) Left Rear Rear*
	4	Speed Sensor (+) Left Rear Rear*
	5	Speed Sensor (-) Right Rear Rear*
	6	Speed Sensor (+) Right Rear Rear*

*Not Used On Basic System

Speed Sensor Resistance Test

The correct resistance for the speed sensor circuit is between 1550 ohms and 2500 ohms.

Measure resistance at the wheel location to check the speed sensor.

Measure resistance at the appropriate ECU harness connector pins to check the cable and speed sensor.

Note: Refer to the chart for pin identification.

FIGURE 24 - Wheel Speed Sensor Harness Circuit Descriptions and Resistance Test

The 17•12 Sensor Memory Diagnostic Trouble Code

The ABS indicator lamp indication and 17•12 diagnostic trouble code are provided to remind the service technician of the need to verify the performance of the ABS wheel speed sensors by driving the vehicle after servicing the sensors. ABS wheel speed sensors do not generate signals unless the wheels are turning. Because of this, certain sensor codes can only be detected when the vehicle is in motion.

The trouble code 17•12 is generated *after the initial sensor codes are cleared*. The ABS indicator lamp remains lit. The trouble codes must be rechecked after clearing the sensor codes in order to see 17•12 reported.

A 17•12 trouble code and ABS indicator lamp signal for sensor code *cannot* be cleared using a ProLink, ServiceRanger software or the diagnostic button. *They can only be cleared by driving the vehicle.* The ABS ECU will clear the 17•12 blink code and turn off the ABS indicator lamp when all active sensor code issues are resolved and the vehicle is driven above 5 mph. The ABS ECU must detect speeds at all monitored wheels for the condition to clear.

Procedure:

1. Check trouble codes.
2. Troubleshoot and eliminate causes for all trouble codes.
3. Clear trouble codes.
4. Check trouble codes again (17•12 will be reported if sensor codes are cleared).
5. If 17•12 error code is reported, drive vehicle above 5 mph (ABS indicator lamp will go out and 17•12 trouble code will be cleared after a short period if all sensor signals are acceptable).

Note: If sensor codes still exist, the ABS indicator lamp will remain lit. The trouble codes will be logged once again after driving the vehicle. If more than one sensor site is affected, the codes may not be re-logged by the ECU until the vehicle has been driven and held above 20 mph for 3-5 minutes.

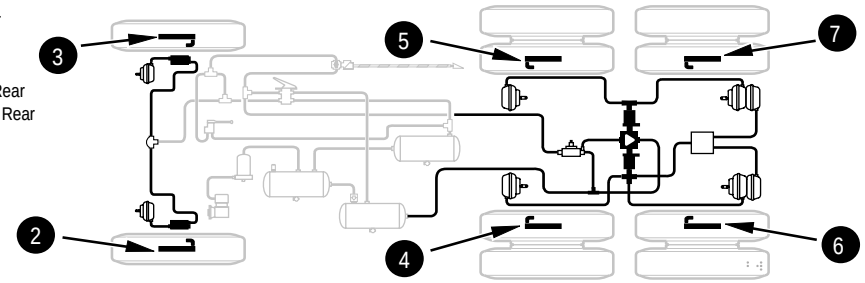
For more detailed troubleshooting, monitor the wheel speeds and cut-out speeds with ServiceRanger or a ProLink hand-held diagnostic tool. Troubleshoot and repair any speed sensor not reporting a wheel speed or showing a high cut-out speed.

Cut-out speeds are an indication of the strength of the sensor signal to the ECU and are proportional to air gap. Cut-out speeds should be in the range of 3-8 mph. Lower numbers indicate a stronger and better signal than higher numbers. High values indicate a sensor with an unreliable or non-existent signal.

Blink Code Sequence

1st

Flashes	Location
2	Left Steer
3	Right Steer
4	Left Rear
5	Right Rear
6	Left Rear Rear
7	Right Rear Rear



1.5 Sec. Pause

2nd

Flashes	Condition	Action
1	Sensor air gap too large.	If necessary, clean and lubricate sensor. Press into mounting hole until it bottoms against tone wheel. Clear trouble code and verify that code is corrected by test driving the vehicle. The indicator lamp will remain on until proper sensor output is detected even though the code has been cleared.
2	Air gap too large or sensor shorted.	Check sensor resistance. If sensor resistance is out of range, replace sensor. Clean and lubricate sensor. Press into mounting hole until it bottoms against tone wheel. Clear trouble code and verify that code is corrected by test driving the vehicle.The indicator lamp will remain on until proper sensor output is detected even though the code has been cleared. Use approved lubricant.
3	Speed sensor signal is noisy.	Examine tone ring for damage. Replace tone ring and/or hub if necessary. Check wheel bearing adjustment. Adjust wheel bearings if necessary. Clear trouble code and verify that code is corrected by test driving the vehicle. The indicator lamp will remain on until proper sensor output is detected even though the code has been cleared.
4	Wheel locked for excessive period of time during an ABS cycle.	Check mechanical function of brake. Check for kinked or restricted hoses. Clear trouble code and verify that code is corrected by test driving the vehicle.The indicator lamp will remain on until proper sensor output is detected even though the code has been cleared.
5	Excessive rate of deceleration found at a wheel site.	Check for damaged tone ring or excessive run out. Repair tone ring and/or adjust wheel bearings. Clear trouble code and test drive the vehicle. The indicator lamp will remain on until proper sensor output is detected even though the trouble code has been cleared.
6	Sensor connection shorted low or high or sensor is open.	Use an ohm meter to verify proper sensor resistance (Fig 24). Check harness for shorts or opens. Repair harness and/or replace sensor as necessary. Clear trouble code and verify that code is corrected by test driving the vehicle. The indicator lamp will remain on until proper sensor output is detected even though the trouble code has been cleared.
7	There is an internal error at the sensor port of the ECU.	Clear trouble code and test drive the vehicle. The indicator lamp will remain on until proper sensor output is detected even though the code has been cleared. If trouble code recurs, or cannot be cleared, replace ECU.
8	A sensor has been found in the wrong location.	Check the control unit configuration and verify that sensors are wired in the proper location for the configuration (Refer to Schematic).

FIGURE 25 - Speed Sensor Diagnostic Trouble Code Troubleshooting Guide

Wheel End Speed Sensor Repair

Front Axle Speed Sensor

The front axle speed sensor is located on the inboard side of the steering knuckle.

CAUTION: Block wheels before beginning this procedure. Follow all standard safety procedures, outlined by, but not limited to, the General Precautions listed on page 13 of this document.

CAUTION: Do not work under a vehicle supported by a jack.

Removal

1. Disconnect sensor cable from harness.
2. Remove the sensor from the sensor bushing. (Do not pull on cable.)
3. Remove the speed sensor friction sleeve from the steer knuckle.

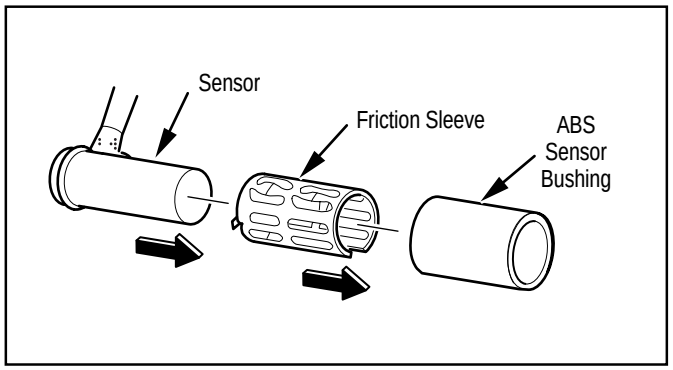


FIGURE 26 - Front Speed Sensor Components

Installation

1. Install the sensor bushing with the flange stops towards the inboard side of the vehicle.
2. Apply high-temperature silicon-based grease to the body of the speed sensor.
3. Push the speed sensor completely into sensor bushing by hand until it stops against the tone ring. The speed sensor is properly installed and adjusted when it is touching the tone ring.

NOTE: The speed sensor must slide freely in and out of the mounting sleeve bore. Operating the vehicle with seized components will damage the speed sensor and the tone ring.

4. Test the installation.
5. Check the cable routing and connections.
6. Clear the trouble codes. A 17•12 trouble code will remain in the system until the vehicle has been driven.
7. Test drive the vehicle and verify that the ABS warning lamp operates properly.

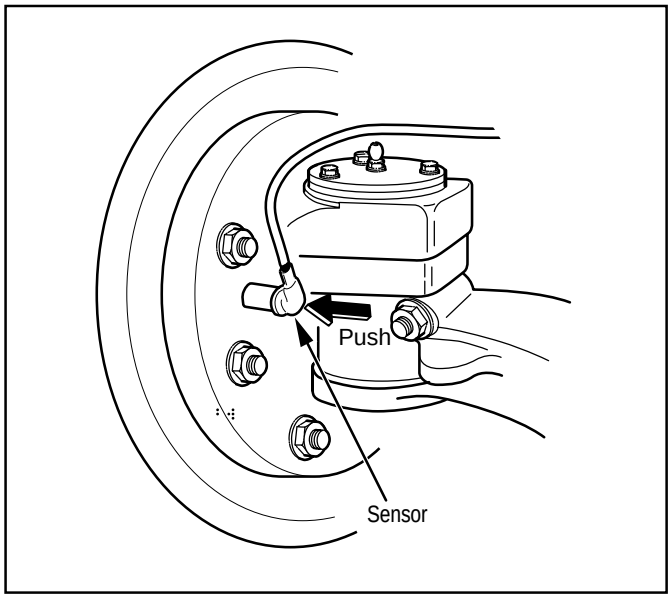


FIGURE 27 - Wheel Speed Sensor Installation

Rear Axle Speed Sensor

The rear axle speed sensor located inside the brake drum and is only accessible by removing the wheel and drum assembly.

NOTE: For diagnostic and service information on in-axle speed sensors, please contact Dana Corporation.

CAUTION: Block wheels before beginning this procedure. Follow all standard safety procedures, outlined by, but not limited to, the General Precautions listed on page 13 of this document.

CAUTION: Do not work under a vehicle supported by a jack.

Removal

1. Back off the slack adjuster to release the brake shoes.
2. Remove the wheel and tire assembly from the axle.
3. Remove the brake drum.
4. Remove the speed sensor with bushing from the mounting block on the axle housing. Use twisting motion and avoid pulling on the cable.
5. Disconnect any fasteners that hold sensor cable to other components and disconnect the speed sensor from the harness.

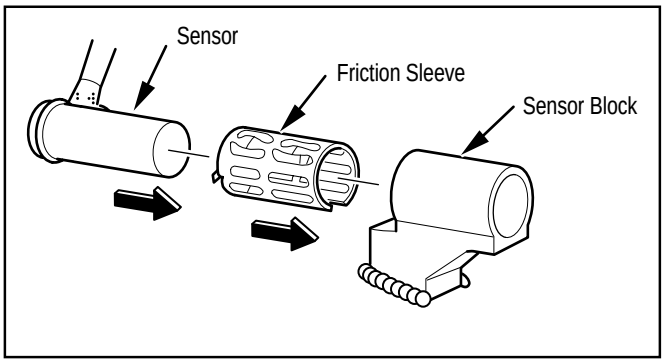


FIGURE 28 - Rear Speed Sensor Components

Installation

1. Install the sensor bushing with the flange stops toward the inboard side of the vehicle.
2. Apply a non-conductive grease lubricant to the body of the speed sensor.
3. Push the speed sensor completely into sensor bushing by hand until it stops against the tone ring. The speed sensor is properly installed and adjusted when it is touching the tone ring.

NOTE: The speed sensor must slide freely in and out of the mounting sleeve bore. Operating the vehicle with seized components will damage the speed sensor and the tone ring.

4. Route the cable to the frame.
5. Connect sensor cable to harness and install fasteners to hold the sensor cable in position.
6. Install the brake drum on the wheel hub.
7. Adjust the rear axle brakes.
8. Install the wheel and tire assembly and tighten the wheel nuts.
9. Test the installation.
10. Check the cable connections.
11. Clear the trouble codes. A 17•12 trouble code will remain in the system until the vehicle has been driven.
12. Test drive the vehicle and verify that the ABS indicator lamp operates properly.

Pressure Modulator Valve (PMV) Troubleshooting

Follow the steps listed below to locate and correct ABS modulator valve problems.

1. Access active trouble code(s) using either the Blink Code procedure or the hand-held tester procedure.
2. Lookup the code description, the possible causes and the repair procedures provided in this section.
3. Perform the recommended repair procedures.
4. After the repairs are completed, clear all codes and check for any additional codes.

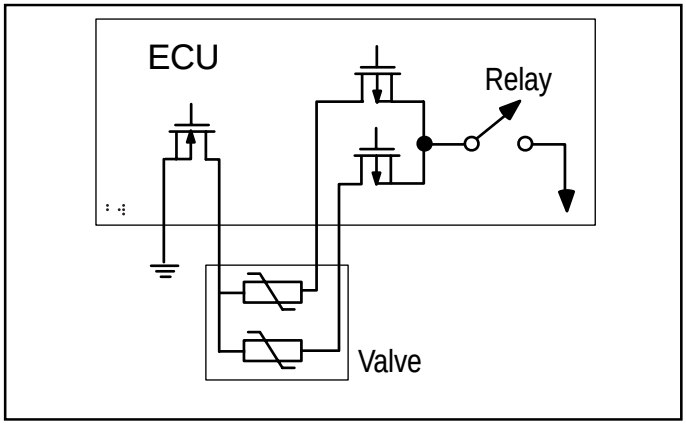
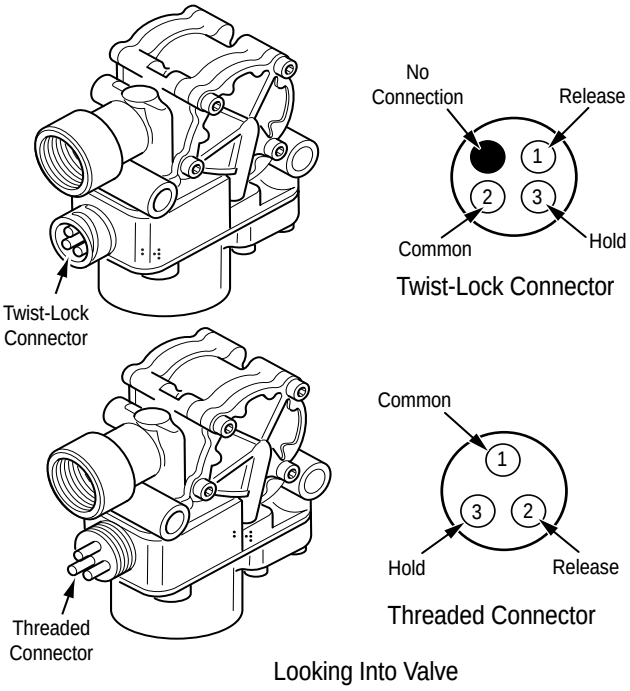


FIGURE 29 - Typical PMV Circuit



Measure From:	Measure To:	Resistance Range:
Common	Hold	3-8 Ohms
Common	Release	3-8 Ohms
HoldRelease	6-16 Ohms	

PMV Resistance Test

Measure resistance at the PMV location to check the valve.

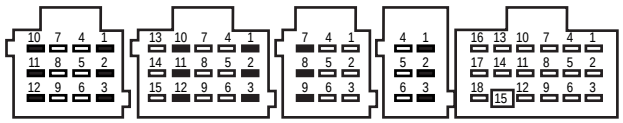
Measure resistance at the appropriate ECU harness connector pins to check the cable and valve.

Note: Refer to the chart for pin identification.

FIGURE 30 - PMV Harness Circuit Descriptions and Resistance Test

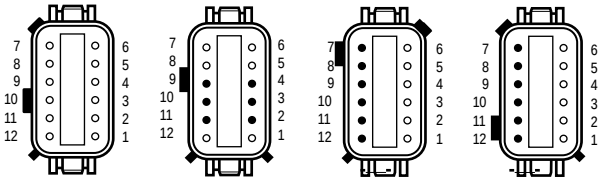
Cab Mount

TOP – Looking into harness connector



E D C B A

Frame Mount



X1 Grey X2 Black X3 Green X4 Brown

Harness Connector	PIN	Circuit Description
B (6-Way)	1	PMV 1 (Release) Left Steer
	2	PMV 1 (Hold) Left Steer
	3	PMV 1 Common Left Steer
C (9-Way)	7	PMV 2 (Release) Right Steer
	8	PMV 2 (Hold) Right Steer
	9	PMV 2 Common Right Steer
D (15-Way)	1	PMV 3 (Release) Left Rear
	2	PMV 3 (Hold) Left Rear
	3	PMV 3 Common Left Rear
D (15-Way)	10	PMV 4 (Release) Right Rear
	11	PMV 4 (Hold) Right Rear
	12	PMV 4 Common Right Rear
E (12-Way)	1	PMV 5 (Release) Left Rear Rear*
6-channel	2	PMV 5 (Hold) Left Rear Rear*
Only	3	PMV 5 Common Left Rear Rear*
E (12-Way)	10	PMV 6 (Release) Right Rear Rear*
6-channel	11	PMV 6 (Hold) Right Rear Rear*
Only	12	PMV 6 Common Right Rear Rear*

*Not Used On Basic System

Harness Connector	PIN	Circuit Description
X2 (Black)	2	PMV 1 (Hold) Left Steer
	10	PMV 1 (Release) Left Steer
	11	PMV 1 Common Left Steer
X2 (Black)	3	PMV 2 (Release) Right Steer
	4	PMV 2 (Hold) Right Steer
	9	PMV 2 Common Right Steer
X3 (Green)	10	PMV 3 (Release) Left Rear
	12	PMV 3 (Hold) Left Rear
	11	PMV 3 Common Left Rear
X3 (Green)	7	PMV 4 (Release) Right Rear
	9	PMV 4 (Hold) Right Rear
	8	PMV 4 Common Right Rear
X4 (Brown)	10	PMV 5 (Release) Left Rear Rear*
6-channel	12	PMV 5 (Hold) Left Rear Rear*
Only	11	PMV 5 Common Left Rear Rear*
X4 (Brown)	7	PMV 6 (Release) Right Rear Rear*
6-channel	9	PMV 6 (Hold) Right Rear Rear*
Only	8	PMV 6 Common Right Rear Rear*

*Not Used On Basic System

FIGURE 31 - PMV Harness Circuit Descriptions and Resistance Test

Blink Code Sequence

1st

Flashes	Location		Flashes	Location	
8	PMV 1	Left Steer	11	PMV4	Right Rear
9	PMV 2	Right Steer	12	PMV5	Left Rear Rear
10	PMV 3	Left Rear	13	PMV6	Right Rear Rear

1.5 Sec. Pause

2nd

Flashes	Condition	Action
1	There is a short between the release solenoid and supply voltage.	Use multimeter to check that valve resistances are correct. If valve is OK check harness for short in wiring.
2	The is a short between the release solenoid and ground.	Use multimeter to check that valve resistances are correct. If valve is OK check harness for short in wiring.
3	There is an open circuit at the release solenoid.	Use multimeter to check that valve resistances are correct. If valve is OK check harness for open in wiring.
4	There is an open circuit in the common line to the valve.	Use multimeter to check that valve resistances are correct. If valve is OK check harness for open in wiring.
5	There is a short between the hold solenoid and supply voltage.	Use multimeter to check that valve resistances are correct. If valve is OK check harness for short in wiring.
6	The is a short between the hold solenoid and ground.	Use multimeter to check that valve resistances are correct. If valve is OK check harness for short in wiring.
7	There is an open circuit at the hold solenoid.	Use multimeter to check that valve resistances are correct. If valve is OK check harness for open in wiring.
8	A valve has been found wired in the wrong location.	Check the control unit configuration and verify that valves are wired in the proper location for the configuration (Refer to Schematic).

1st

Flashes	Location
10 or 11	PMV Commons

1.5 Sec. Pause

2nd

Flashes	Condition	Action
9	Stray voltage has been found on the common line of one or more of the valves	Unplug ECU and check for voltage on the PMV common pins. If voltage is found, repair harness. If no problem is found in harness, replace ECU. Note: Before replacing ECU clear trouble codes and verify that trouble code is still present (Refer to Schematic).
10	A short to supply voltage has been found on the common line of one or more of the valves	Unplug ECU and check for short to 12 volts on PMV common pins. If any are shorted to supply, repair harness. If no short is found in harness, replace ECU. Note: Before replacing ECU, clear trouble codes and verify that trouble code is still present (Refer to Schematic).
11	A short to ground has been found on the common line of one or more of the valves	Unplug ECU and check for short to ground on PMV common pins. If any are shorted to ground, repair harness. If no short is found in harness, replace ECU. Note: Before replacing ECU, clear trouble codes and verify that trouble code is still present (Refer to Schematic).

FIGURE 32 - PMV Diagnostic Trouble Code Troubleshooting Guide

ABS Modulator Valve

Removal

1. Turn ignition switch to the OFF position, and apply parking brake.

CAUTION: Block wheels before beginning this procedure. Follow all standard safety procedures, outlined by, but not limited to, the General Precautions listed on page 13 of this document.

2. Disconnect the wiring connector from the ABS valve.
3. Disconnect the air lines from the supply and delivery ports of the ABS valve.
4. Disconnect the valve mounting fasteners.
5. Remove the ABS valve.

NOTE: To service either modular valve or the relay valve, remove the entire assembly and then replace the individual components (valve).

Installation

1. Install the valve. Torque fasteners to manufacturers specification.
2. Connect air lines.
   - Supply to port 1 on valve.
   - Service brake chamber to delivery port 2.
3. Connect the wiring connector to the ABS valve.
4. Test the installation:
   - Modulator Valve Leak Test—Make and hold brake application. No audible air leaks are permitted.
   - Modulator Valve Component Test with Hand-Held Diagnostic Tool—Select valve routines. Verify proper valve location and operation with tool. Drive the vehicle and verify ABS indicator lamp operates properly.
5. Make several brake applications and check for prompt brake chamber applications and release at all wheels. Check the cable connections.
6. Clear codes.
7. Drive the vehicle and verify that the ABS indicator lamp operates properly.

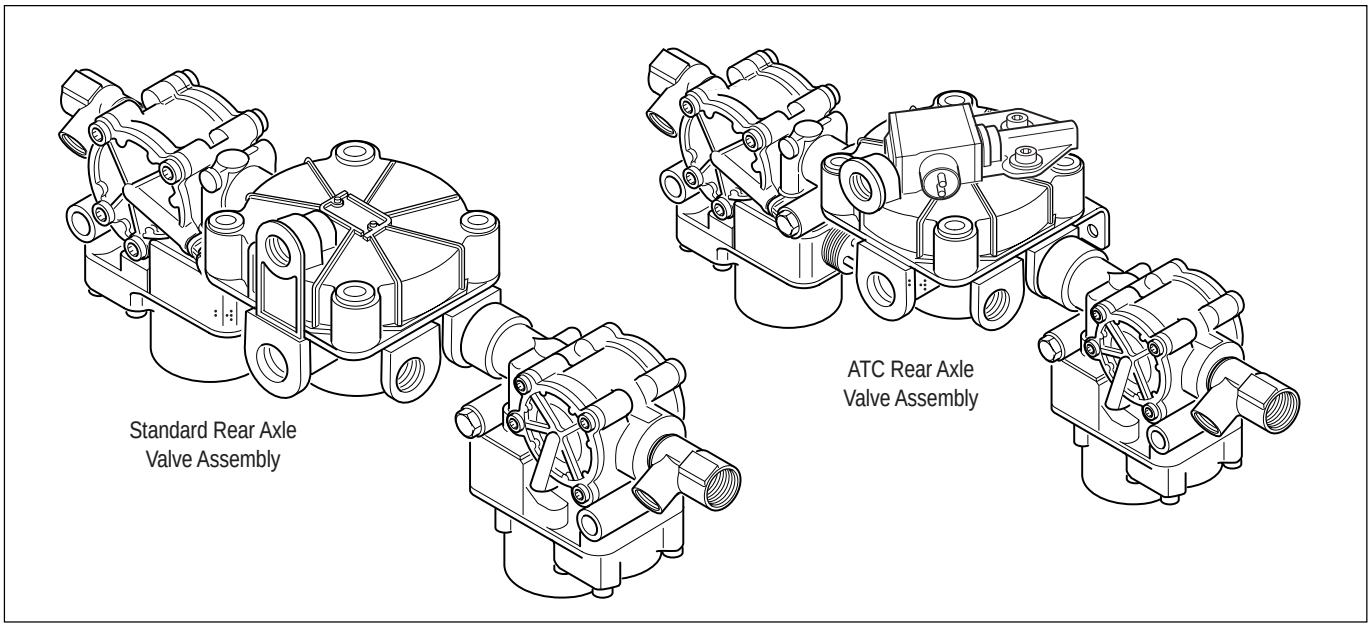


FIGURE 33 - Rear Axle Valve Assemblies – Standard and ATC Version Shown

Performance Test of the Relay Valve

CAUTION: Block wheels before beginning this procedure. Follow all standard safety procedures, outlined by, but not limited to, the General Precautions listed on page 13 of this document.

1. Park vehicle on level surface and block wheels.
2. Release parking brake and fully charge the air system (governor cut out point).
3. Turn the engine OFF. Apply the service brake several times, then hold and check for prompt brake air chamber application and release at all wheels.
4. Apply brake, then hold. Coat outside of relay valve (where cover joins body) and connection between modulator valve and relay valve with a soap solution. No leakage is permitted.
5. If a sluggish response is noted at all wheels, inspect for kinked or obstructed air line leading to or from valve.
6. Increase system air pressure to governor cutoff. With the brakes released, coat exhaust port of relay valve with a soap solution. Leakage of a 1" bubble in 5 seconds is permissible.
7. Depress foot valve and keep depressed. Coat exhaust port with a soap solution. Leakage of a 1" bubble in 3 seconds is permissible.

Automatic Traction Control (ATC) Valve Troubleshooting

The following ATC troubleshooting pages provide the basic information necessary to: identify the diagnostic trouble code; locate the problem; review the possible cause(s); select the correct solution and utilize proper repair procedures.

Follow the steps listed below to locate and correct ATC problems.

1. Access active diagnostic trouble code(s) using either the Blink Code procedure or the hand-held tester procedure.
2. Lookup the code description, the possible causes and the repair procedures provided in this section.
3. Perform the recommended repair procedures.
4. After the repairs are completed, clear all codes and check for any additional codes.

Whether the ATC Valve is used as a stand-alone valve as shown in Figure 34 or is integrated into the cover of a relay valve as shown in Figure 33, the troubleshooting procedure is the same.

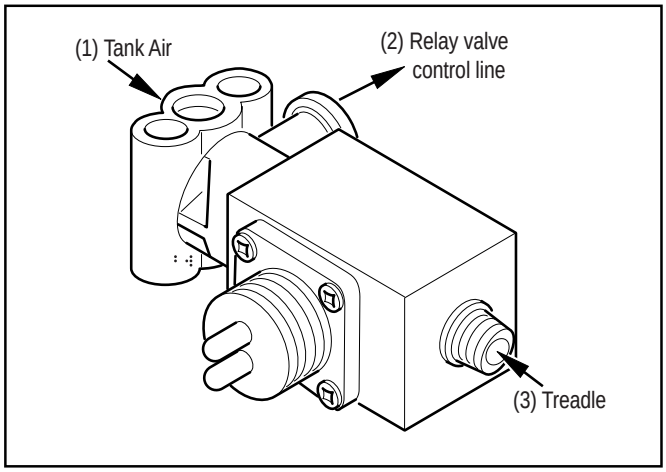
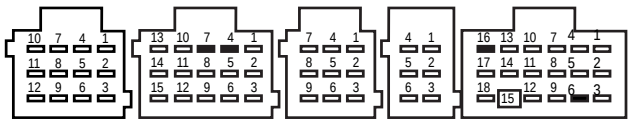


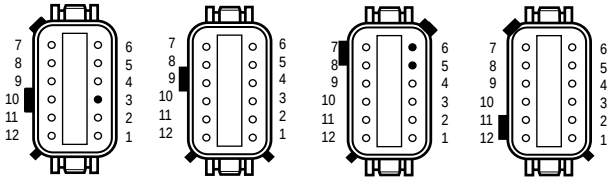
FIGURE 34 - ATC Valve

Cab Mount

TOP – Looking into harness connector



Frame Mount



Harness Connector	PIN	Circuit Description
A (18-Way)	6	ATC Mud and Snow Switch
	16	ATCL (ATC Light)
D (15-Way)	4	ATC Valve +
	7	ATC Valve –

Harness Connector	PIN	Circuit Description
X1 (Grey)	3	ATCL (ATC Light/ATC Switch)
X3 (Green)	5	ATC Valve –
	6	ATC valve +

ATC Valve Resistance Test

The correct resistance for the ATC Valve circuit is between 9 ohms and 15 ohms.

Measure resistance at the ATC Valve to check the valve.

Measure resistance at the appropriate ECU harness connector pins to check the cable and valve.

Note: Refer to the chart for pin identification.

FIGURE 35 - ATC Harness Circuit Descriptions and Resistance Test

Blink Code Sequence

Flashes	Location
14	ATC Valve

1st

1.5 Second Pause

2nd

Flashes	Condition	Response
5	Solenoid in ATC valve shorted high.	Use multimeter to check that valve resistances are correct (fig 34). If valve is OK check harness for open in wiring.
6	Solenoid in ATC valve shorted to ground.	Use multimeter to check that valve resistances are correct (fig 34). If valve is OK check harness for open in wiring.
7	ATC valve open circuit.	Use multimeter to check that valve resistances are correct (fig 34). If valve is OK check harness for open in wiring.
8	ATC valve found when it should not be present.	Verify proper system configuration and components. Clear faults. If error cannot be cleared or recurs, replace ECU.

FIGURE 36 - ATC Diagnostic Trouble Code Troubleshooting Guide

ATC Valve Removal

CAUTION: Block wheels before beginning this procedure. Follow all standard safety procedures, outlined by, but not limited to, the General Precautions listed on page 13 of this document.

1. Disconnect the wiring connector from the ATC valve.
2. Disconnect the air lines from the supply (port 1) and delivery port (port 2) and treadle (port 3) of the ATC valve.
3. Disconnect the valve mounting fasteners, and remove the valve.

Installation

1. Install the ATC valve. Torque fasteners to manufacturers specification.
2. Connect Air lines supply (port 1) delivery port (port 2) and treadle (port 3) of the ATC valve.
3. Install the wiring connector to the ATC valve.
4. Test the installation.
   - Traction Control Valve – Leak Test:

Make and hold brake application. No audible air leaks are permitted.

- Traction Control Valve Component Test with Hand-Held Diagnostic Tool:

Select Traction Control Valve

Verify Traction control light operation

Drive the vehicle and verify ABS indicator lamp operates properly.

CAUTION: Do not start and engage the transmission with one wheel raised from the floor. With ATC, power will go to the wheel on the floor and cause the vehicle to move. See page 20 to disable ATC for dyno testing.

Blink Code Sequence

1st

Flashes	Location
14	ECU, Engine Interface

1.5 Sec. Pause

2nd

Flashes	Condition	Action
12	No connection found to engine data link (J1922/J1939).	Refer to electrical schematic. Check for proper connection of data link to ECU. Verify that polarity is correct. Unplug connector at ECU. There should be a voltage between 0 and 2.5 volts on J1922/J1939 (–) and a voltage between 2.5 and 5 volts on J1922/J1939 (+). If vehicle is not equipped with J1922/J1939 engine link, use diagnostic tool to reconfigure ECU.

1st

Flashes	Location
15	ECU

1.5 Sec. Pause

2nd

Flashes	Condition	Action
1–11	ECU Internal Fault	If fault cannot be cleared, replace ECU.

FIGURE 37 - System and ECU Diagnostic Trouble Codes Troubleshooting Guide

Blink Code Sequence

1st

Flashes	Location
16	Power Circuits

1.5 Sec. Pause

2nd

Flashes	Condition	Action
1 or 5	Excessive voltage on PMV Power	Verify that vehicle system voltage is OK (i.e. 9 to 16 volts). If voltage is out of range, correct system problem. Unplug connector at ECU and turn on ignition switch. If the voltage on PMV Power is different than system voltage, repair wiring. Clear trouble codes and verify that the indicator lamp turns out after bulb check.
2 or 6	Low voltage on PMV Power	Verify that vehicle system voltage is OK (i.e. 9 to 16 volts). If voltage is out of range, correct system problem. Unplug connector at ECU and turn on ignition switch. If the voltage on PMV Power is different than system voltage, repair wiring. Clear trouble codes and verify that the indicator lamp turns out after bulb check.
3 or 7	No voltage found on PMV Power	Verify that vehicle system voltage is OK (i.e. 9 to 16 volts). If voltage is out of range, correct system problem. Unplug connector at ECU and turn on ignition switch. If the voltage on PMV Power is different than system voltage, repair wiring. Clear trouble codes and verify that the indicator lamp turns out after bulb check.
4 or 8	Open circuit on PMV Ground	Unplug connector at ECU and check for continuity to ground on PMV Ground. If continuity to ground is not present, repair harness.
9	Excessive voltage found on ECU Power	Verify that vehicle system voltage is OK (i.e. 9 to 16 volts). If voltage is out of range, correct system problem. Unplug connector at ECU and turn on ignition switch. If the voltage on pin A-8 is different than system voltage, repair wiring. Clear trouble codes and verify that the indicator lamp turns out after bulb check.
10	Low voltage found on ECU Power	Verify that vehicle system voltage is OK (i.e. 9 to 16 volts). If voltage is out of range, correct system problem. Unplug connector at ECU and turn on ignition switch. If the voltage on PMV Power is different than system voltage, repair wiring. Clear trouble codes and verify that the indicator lamp turns out after bulb check.
11	Voltage difference between PMV Power inputs is too high	Verify that vehicle system voltage is OK (i.e. 9 to 18 volts). If voltage is out of range, correct system problem. Unplug connector at ECU and turn on ignition switch. If the voltage on one PMV Power pin differs from the other by greater than 0.5 volts, repair wiring. (Check circuit breakers and/or fuses on diagonal supply line.) Clear trouble codes and verify that the indicator lamp turns out after bulb check.

FIGURE 38 - Power Circuit Diagnostic Trouble Codes Troubleshooting Guide

Blink Code Sequence

Flashes	Location
17	Miscellaneous

1st

1.5 Sec. Pause

2nd

Flashes	Condition	Action
1	Retarder control relay shorted high or open circuit.	Use multimeter to verify proper voltage at the retarder control relay.
2	Retarder control relay shorted low. or open circuit	Use multimeter to verify proper voltage at the retarder control relay.
3	J1922/1939 data link not functioning. (Retarder)	Unplug connector at ECU. There should be a voltage between 0 and 2.5 volts on J1939/J1922 (–) and a voltage between 2.5 and 5.0 volts on J1939/J1922 (+). Refer to schematic and correct wiring harness as required.
4	J1922/1939 data link time out.	Unplug connector at ECU. There should be a voltage between 0 and 2.5 volts on J1939/J1922 (–) and a voltage between 2.5 and 5.0 volts on J1939/J1922 (+). Refer to schematic and correct wiring harness as required.
5	Tire size, front to rear out of range.	There is too great a difference in the rolling radius of the front and rear tires. Steer axle tire radius cannot be more than 20% above rears or 10% below. If the static loaded radius of the rear tires is outside the range 15.9 to 21.5 inches the ECU must be recalibrated using a diagnostic tool.
6	Tire size out of range or parameter fault.	There is too great a difference in the rolling radius of the front and rear tires. Steer axle tire radius cannot be more than 20% above rears or 10% below. If the static loaded radius of the rear tires is outside the range 15.9 to 21.5 inches the ECU must be recalibrated using a diagnostic tool.
7	Brake light switch not pushed at this power cycle.	Press brake pedal. If error does not clear, check for missing connection at brake light switch. If the brake is not applied you should measure the resistance of the brake light bulb (bulb broken?). If the brake is applied, you should measure vehicle system voltage. (i.e. 9…16v)
8	ATC system is disabled for dynamometer test.	Cycle ignition switch and ATC will be re-enabled.
10	Warning light short, low or open	Diagnostic switch may have been pressed for an excessive period of time (>30 seconds). If not check wiring associated with indicator lamp.
12	Sensor memory bit is set	This trouble code should clear when the vehicle is driven and the ECU is able to read sensor output voltage. If this does not happen, verify that the sensors are properly adjusted (pressed full in to tone wheels.)

Note: For codes 17•3 and 17•4 the problem may be within the engine controller, another controller on the data link or within the wiring or connectors.

FIGURE 39 - Miscellaneous Diagnostic Trouble Codes Troubleshooting Guide

Cab Mount ECU Pin Identification

This section shows how to identify Cab Mount ECU harness connectors and pin locations. The charts provide a brief description of the signal carried by each pin.

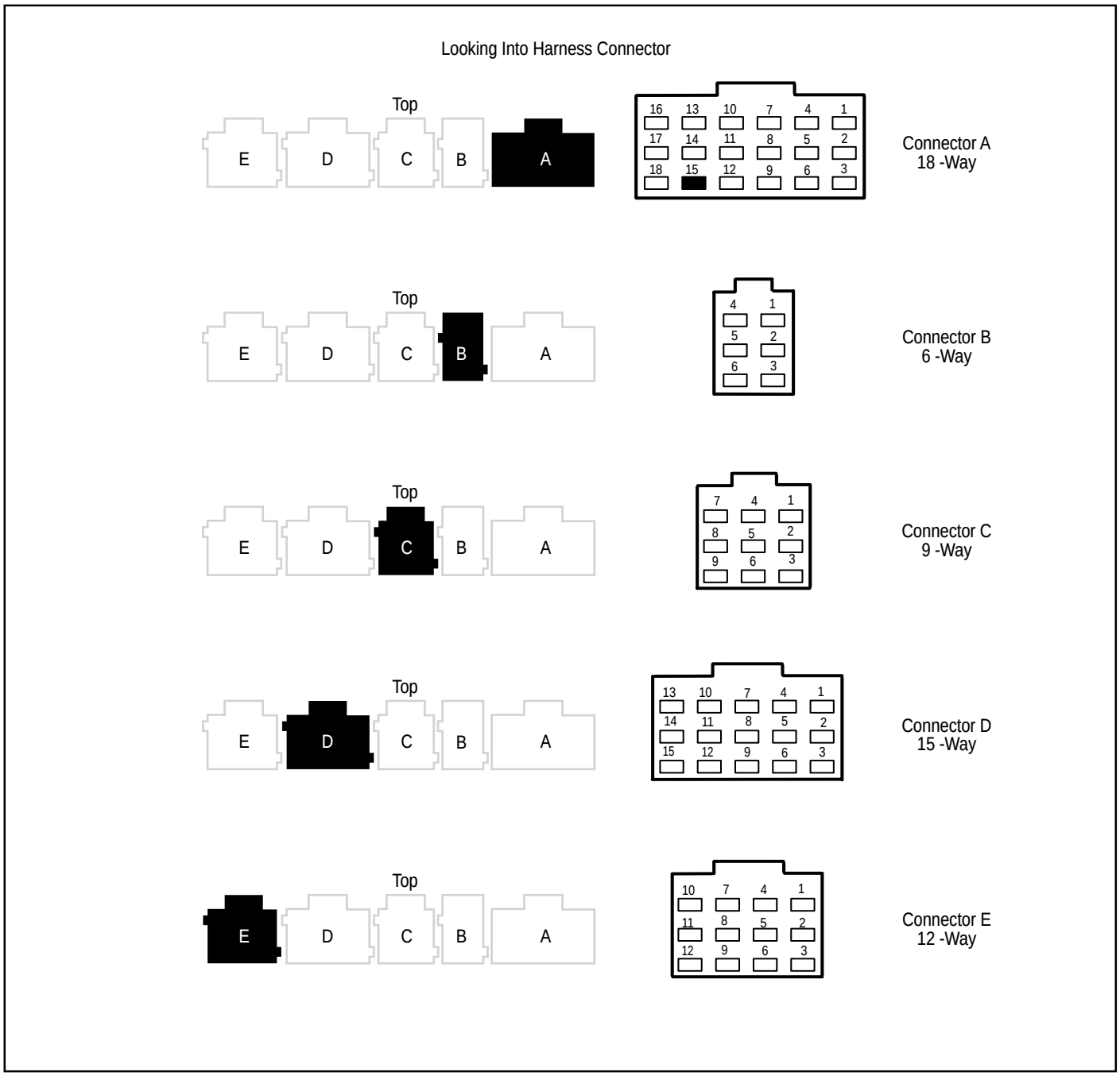


FIGURE 40 - Cab Mount ECU – Connector Layout

ECU CONNECTOR	PIN	DESCRIPTION
A (18-Way)	1	J1922/J1939 -
	2	Gen 4™ ABS J1939 Shld/Gen 5™ ABS TIL
	3	J1922/J1939 +
	4	NC
	5	Off Road ABS Switch (ORS)
	6	ATC Mud & Snow Switch
	7	Ignition, Switched
	8	V Bat 2
	9	V Bat 1
	10	Ground - ECU
	11	Ground - Diagonal 2
	12	Ground - Diagonal 1
	13	SAE J1587-
	14	SAE J1587+
	15	NC, Interlock
	16	ATC Light
	17	Retarder Relay
	18	Indicator Lamp/Diagnostic Switch
B (6-Way)	1	PMV1 (Left Steer), Rel Solenoid
	2	PMV1 (Left Steer), Hold Solenoid
	3	PMV1 (Left Steer), Common
	4	Speed Sensor 2 (Left Steer) +
	5	Speed Sensor 2 (Left Steer) -
	6	Brake Light Switch
C (9-Way)	1	NC
	2	NC
	3	NC
	4	Speed Sensor 3 (Right Steer) +
	5	Speed Sensor 3 (Right Steer) -
	6	NC
	7	PMV2 (Right Steer), Rel Solenoid
	8	PMV2 (Right Steer), Hold Solenoid
	9	PMV2 (Right Steer), Common

ECU CONNECTOR	PIN	DESCRIPTION
D (15-Way)	1	PMV3 (Left Rear), Rel Solenoid
	2	PMV3 (Left Rear), Hold Solenoid
	3	PMV3 (Left Rear), Common
	4	ATC Valve -
	5	Speed Sensor 4 (Left Rear) +
	6	Speed Sensor 4 (Left Rear) -
	7	ATC Valve +
	8	Speed Sensor 5 (Right Rear) +
	9	Speed Sensor 5 (Right Rear) -
	10	PMV4 (Right Rear), Rel Solenoid
	11	PMV4 (Right Rear), Hold Solenoid
	12	PMV4 (Right Rear), Common
	13	NC
	14	NC
	15	NC
E (12-Way)	1	PMV5 (Left Rear Rear), Rel Solenoid
	2	PMV5 (Left Rear Rear), Hold Solenoid
	3	PMV5 (Left Rear Rear), Common
	4	NC
	5	Speed Sensor 6 (Left Rear Rear) +
	6	Speed Sensor 6 (Left Rear Rear) -
	7	NC
	8	Speed Sensor 7 (Right Rear Rear) +
	9	Speed Sensor 7 (Right Rear Rear) -
	10	PMV6 (Right Rear Rear), Rel Solenoid
	11	PMV6 (Right Rear Rear), Hold Solenoid
	12	PMV6 (Right Rear Rear), Common

FIGURE 41 - Cab Mount ECU – Pin Identification Chart

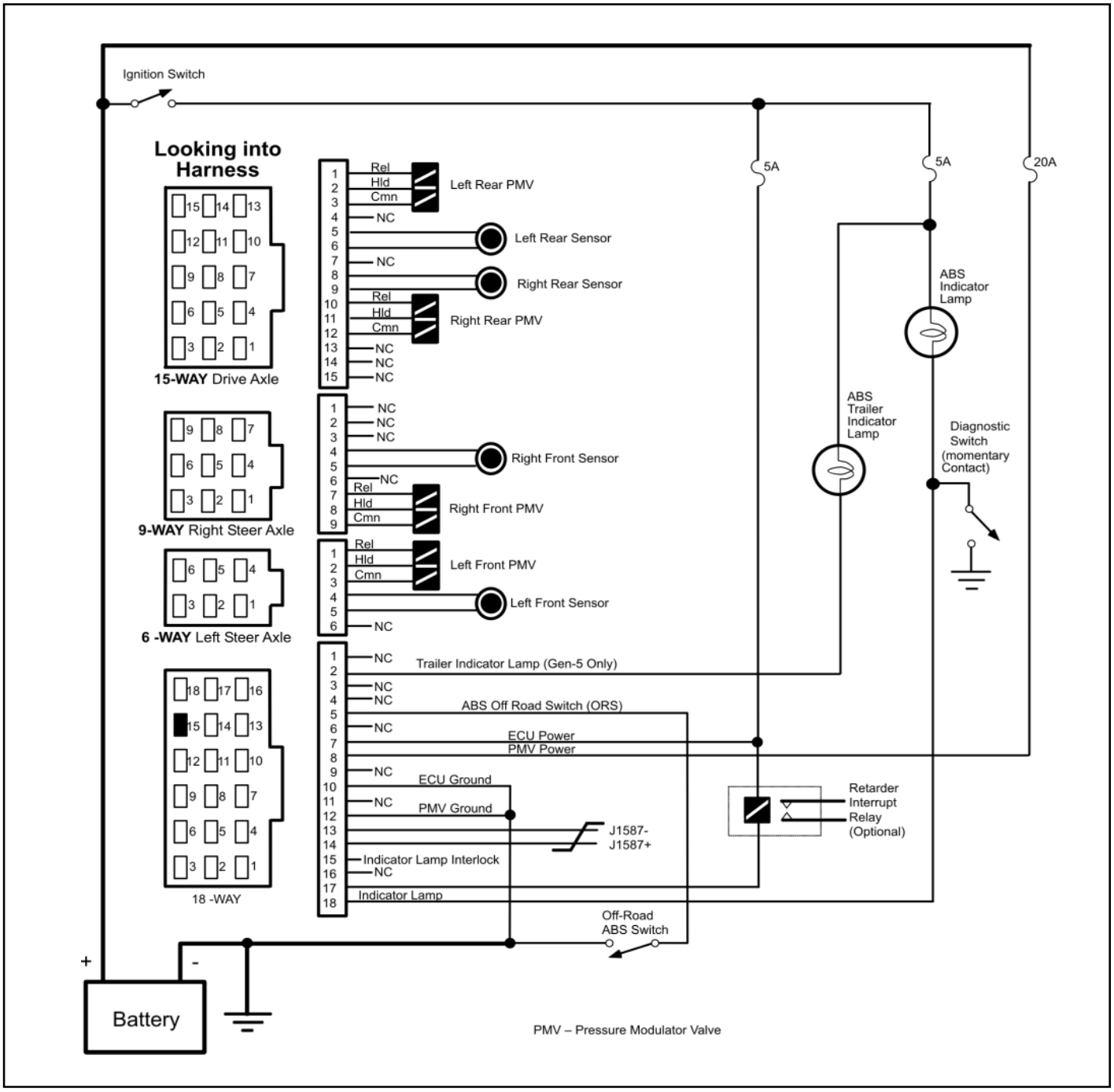


FIGURE 42 - Gen 4™ and Gen 5™ Basic Cab Mount ABS Electrical Schematic

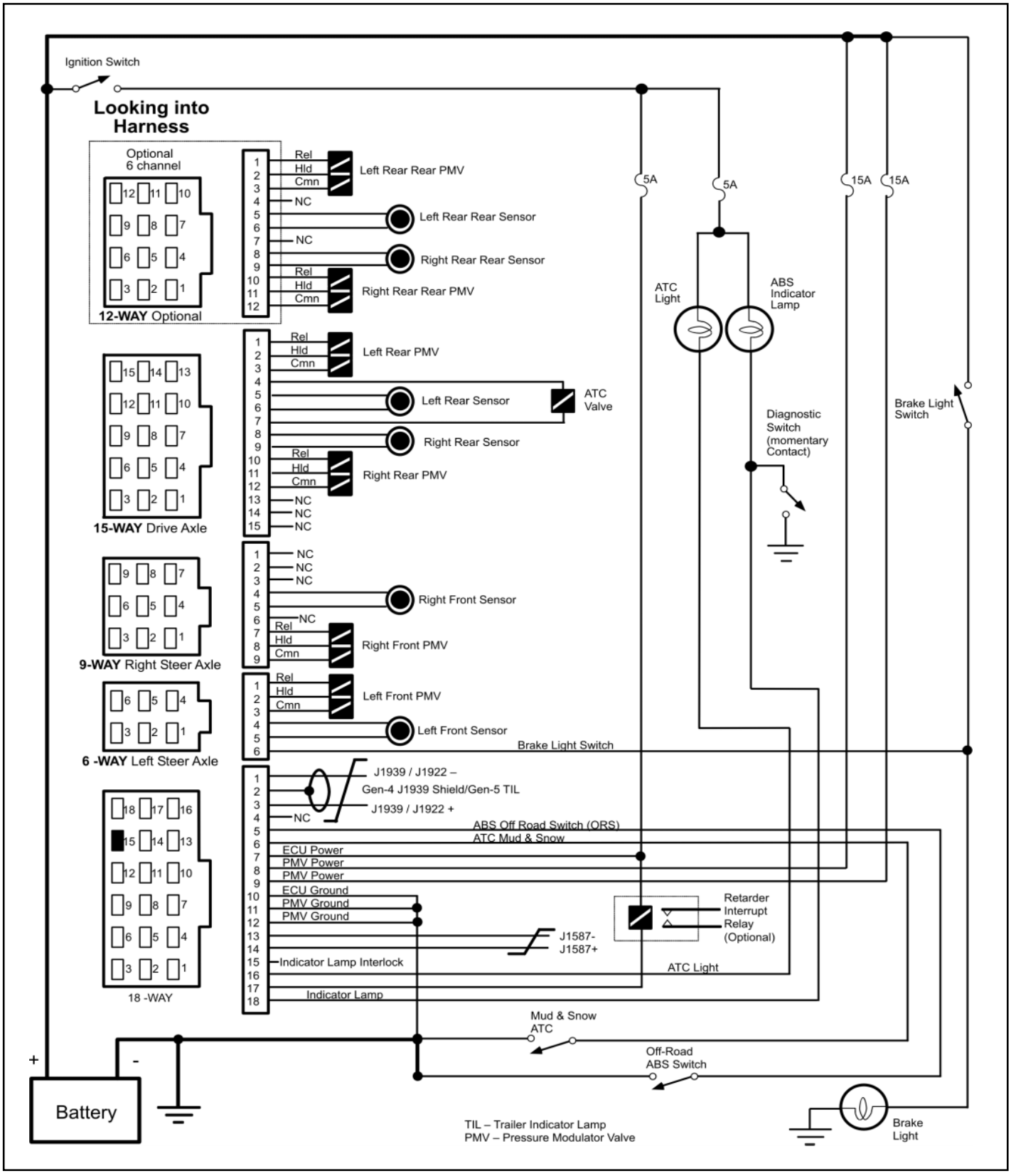


FIGURE 43 - Gen 4™ and Gen 5™ Standard Cab Mount ABS Electrical Schematic

Frame Mount ECU Pin Identification

This section shows how to identify Frame Mount ECU harness connectors and pin locations. The charts provide a brief description of the signal carried by each pin.

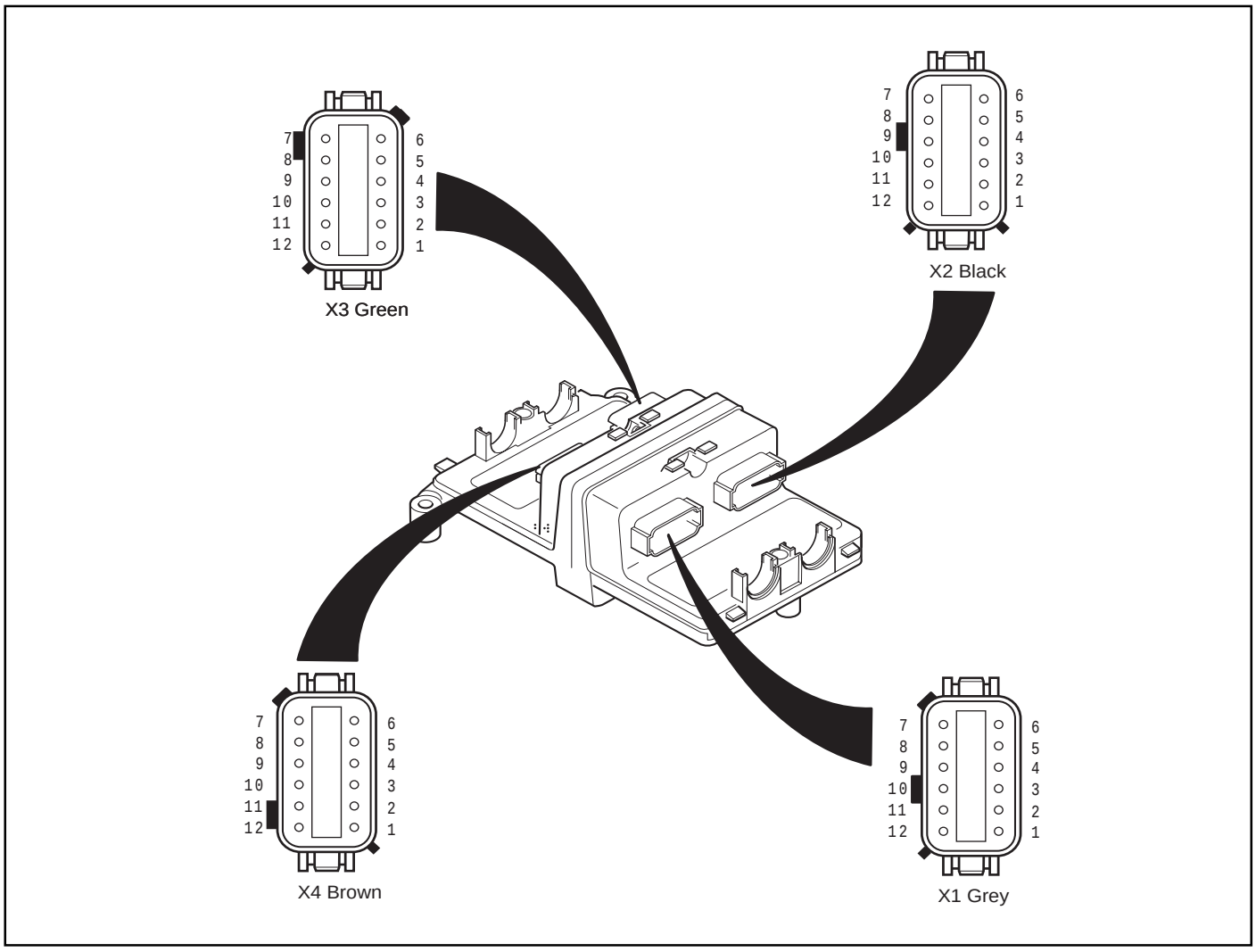


FIGURE 44 - Cab Mount ECU – Pin Identification Chart

X1 Grey

Pin	Signal	Description
X1-1	IGN_1	Ignition-1
X1-2	IGN_2	Ignition-2
X1-3	ATCL	ATC Light/ATC Switch
X1-4	1587_+	J1587+
X1-5	RET	Retarder Control
X1-6	ENG_-	J1922/1939 Engine Control Link-
X1-7	ENG_+	J1922/1939 Engine Control link+
X1-8	SHLD/TIL	Gen 4™ ABS J1939 Shield/Gen 5™ ABS TIL
X1-9	1587_-	J1587-
X1-10	WL	ABS WL/Diagnostic Switch
X1-11	GND_2	Ground
X1-12	GND_1	Ground

X3 Green

Pin	Signal	Description
X3-1	SS_{LR}	Speed Sensor, Left Rear-
X3-2	SS_{LR}	Speed Sensor, Left Rear+
X3-3	SS_{RR}	Speed Sensor, Right Rear-
X3-4	SS_{RR}	Speed Sensor, Right Rear+
X3-5	$ATCV_-$	Traction Control Valve-
X3-6	$ATCV_+$	Traction Control Valve+
X3-7	REL_{RR}	Release Sol, Right Rear
X3-8	CMN_{RR}	Common, Right Rear
X3-9	HLD_{RR}	Hold Sol, Right Rear
X3-10	REL_{LR}	Release Sol, Left Rear
X3-11	CMN_{LR}	Common, Left Rear
X3-12	HLD_{LR}	Hold Sol, Left Rear

X2 Black

Pin	Signal	Description
X2-1	BLS	Brake Light Switch
X2-2	HLD_{LS}	Hold Sol, Left Steer
X2-3	REL_{RS}	Release Sol, Right Steer
X2-4	HLD_{RS}	Hold Sol, Right Steer
X2-5	SS_{RS}	Speed Sensor, Right Steer-
X2-6	SS_{BS}	Speed Sensor, Right Steer+
X2-7	SS_{LS}	Speed Sensor, Left Steer-
X2-8	SS_{LS}	Speed Sensor, Left Steer+
X2-9	CMN_{RS}	Common, Right Steer Valve
X2-10	REL_{LS}	Release, Left Steer Valve
X2-11	CMN_{LS}	Common, Left Steer Valve
X2-12	ORS	Off Road Switch

X4 Brown

Pin	Signal	Description
X4-1	DLC_-	Diff Lock Control-
X4-2	DLC_+	Diff Lock Control+
X4-3	SS_{LRR}	Speed Sensor Left Rear Rear-
X4-4	SS_{LRR}	Speed Sensor Left Rear Rear+
X4-5	SS_{RRR}	Speed Sensor Right Rear Rear-
X4-6	SS_{RRR}	Speed Sensor Right Rear Rear+
X4-7	REL_{RRR}	Release Sol, Right Rear Rear
X4-8	CMN_{C+}	Common, Right Rear Rear
X4-9	HLD_{RRR}	Hold Sol, Right Rear Rear
X4-10	REL_{LRR}	Release Sol, Left Rear Rear
X4-11	CMN_{LRR}	Common, Left Rear Rear
X4-12	HLD_{LRR}	Hold Sol, Left Rear Rear

FIGURE 45 - Frame Mount ECU – Pin Identification Chart

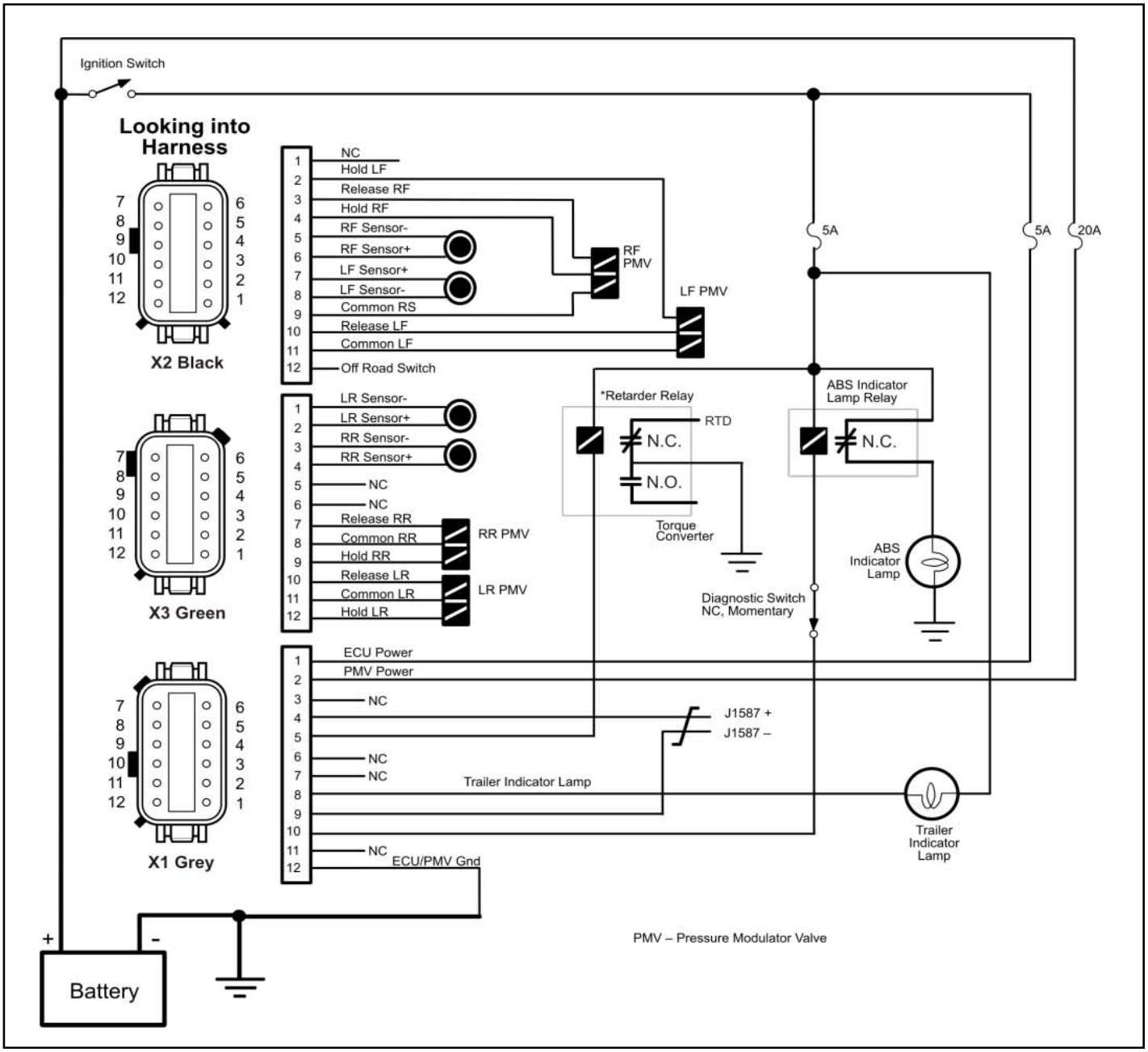


FIGURE 46 - Gen 5™ Basic Frame Mount ABS Electrical Schematic

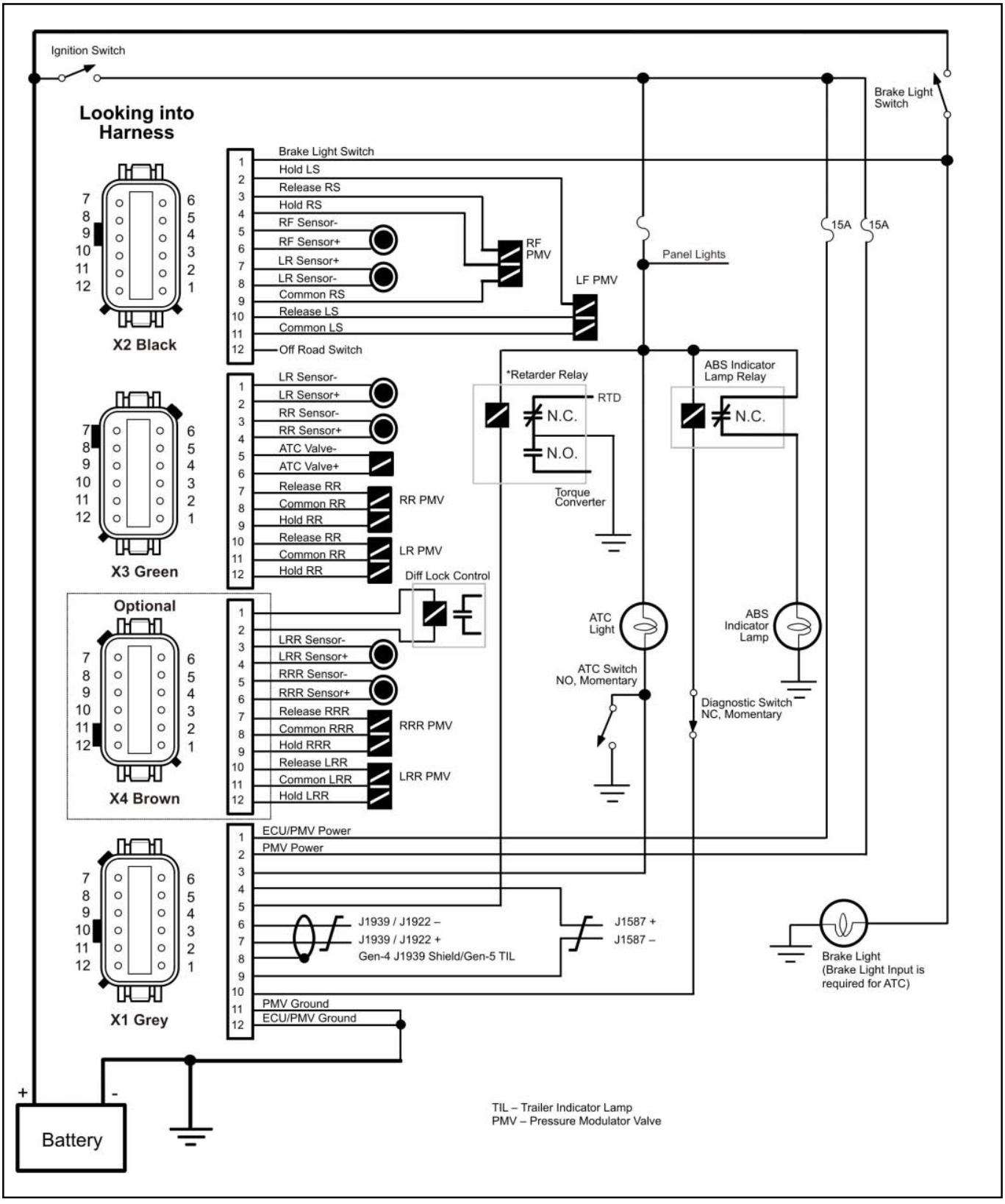


FIGURE 47 - Gen 4™ and Gen 5™ Standard Frame Mount ABS Electrical Schematic

Glossary

ABS — Antilock Brake System.

ABS Event — Impending wheel lock situation that causes the ABS controller to activate the modulator valve(s).

Air Gap — Distance between the Sensor and tone ring.

Anti-Compounding Valve — Prevents the application of the service and spring brakes at the same time. Depending on vehicle design, the anti-compounding valve may be installed in combination with a relay valve or quick release valve.

Apply Timing — The time from the movement of the service brake control for each brake chamber to reach 60 psi, with an initial service reservoir pressure of 100 PSI.

ASR — Automatic Slip Regulation. Another name for traction control.

ATC — Automatic Traction Control. An additional ABS function in which engine torque is controlled and brakes are applied differentially to enhance vehicle traction.

ATC Light — A light that indicates when traction control is operating.

Channel — A controlled wheel site.

CAN — Controller Area Network. J1939 is an SAE version of the CAN link.

Clear Codes — System to erase historical faults from the ECU, from either the Diagnostic Button or from a hand-held diagnostic tool (only repaired faults may be cleared).

Coefficient of Friction — The horizontal force required to move a body (on a relatively smooth level surface) divided by the weight of the body.

Configuration — The primary objective is to identify a “normal” set of sensors and modulators for the Electronic Control Unit, so that it will identify future missing sensors and modulators.

Crack Pressure — The ascending input pressure or input force to an air valve required to initiate output pressure of flow.

Diagonal Control — ABS is configured with two diagonal circuits. Diagonal control allows each control circuit to provide electrical control of modulator valves on opposite sides of the vehicle.

Diagnostic Connector — Diagnostic receptacle in vehicle cab for connection of J1587 hand-held or PC based test equipment. The tester can initiate test sequences, and can also read system parameters.

Diagnostic Switch — A switch used to activate blinks codes.

Diagnostic Trouble Code — A condition that interferes with the generation or transmission of response or control signals in the vehicle's ABS system that could lead to the functionality of the ABS system becoming inoperable in whole or in part.

Differential Braking — Application of brake force to a spinning wheel so that torque can be applied to wheels which are not slipping.

ECU — Electronic Control Unit.

FMVSS-121 — Federal Motor Vehicle Safety Standard which regulates air brake systems.

Friction Sleeve — A beryllium copper sleeve which has fingers cut into it. It is pressed between an ABS sensor and mounting hole to hold the sensor in place.

Indicator Lamp — An amber light which indicates the operating status of an antilock system. When the indicator lamp is on, ABS is disabled and the vehicle reverts to normal brake operation.

IR — Independent Regulation. A control method in which a wheel is controlled at optimum slip, a point where retardation and stability are maximized. The brake pressure that is best for the wheel in question is directed individually into each brake chamber.

J1587 — The SAE heavy duty standard diagnostic data link.

J1708 — An SAE standard which defines the hardware and software protocol for implementing 9600 baud heavy vehicle data links. Both J1587 and J1922 are versions of J1708 data links.

J1922 — The SAE heavy vehicle data link which operates according to J1708 protocol. It is generally used for ATC or automatic transmission interface to an engine.

J1939 — A high speed 250,000 baud data link which is expected to replace J1922.

MIR — Modified Independent Regulation. A method of controlling the opposite sides of a steer axle during ABS operation so that torque steer and stopping distance are minimized. Usually control begins at pure select low and moves towards independent control as the cycle progresses.

PLC — Power Line Carrier. The serial communication protocol used to communicate with the trailer over the blue full time power wire.

PMV — Pressure Modulator Valve. An air valve which is used to vent or block air to the brake chambers to limit or reduce brake torque.

QR — Quick Release. Quick release Valves allow faster release of air from the brake chamber after a brake application. To balance the system, quick release valves have hold off springs that produce higher crack pressures (when the valves open).

Relay Valve — Increases the application speed of the service brake. Installed near brakes with larger air chambers (type 24 or 30). The treadle valve activates the relay valve with an air signal. The relay valve then connect its supply port to its delivery ports. Equal length air hose must connect the delivery ports of the relay valve to the brake chambers.

Release Timing — The measurement in time from initial brake movement to reach 5 psi with 95 psi initial pressure at the brake chambers.

Retarder Relay — A relay which is used to disable a retarder when ABS is triggered.

Select High — A method of ABS control in which the brake torque is released at several wheels when the last wheel begins to lock.

Select Low — The brake pressures level is the same on both wheels of a given axle. The pressure level is based on the wheel which is running at the lower friction coefficient.

Select Smart — The difference in pressure between the left and right brake chamber does not exceed a certain amount. This leads to the wheel which is running at the high friction coefficient being braked less strongly.

Sensor Bushing — A bushing which is pressed into steer axles to hold a wheel speed sensor and friction sleeve.

Stored Faults — A Fault that occurred.

TCS — Traction Control System, another name for ATC or ASR.

Tone Ring — A ring that is usually pressed into a wheel hub that has a series of teeth (usually 100) and provides actuation for the speed sensor. Note maximum run out is .008.

Bendix

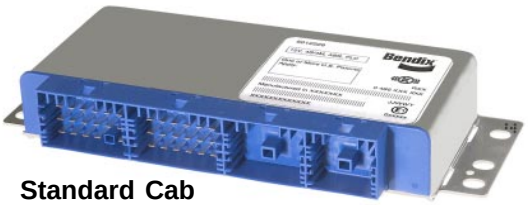
Service Data

SD-13-4863

Bendix® EC-60™ ABS / ATC Controllers (Standard & Premium Models)

Frame and Cab Mount

Standard Frame



Standard Cab

Premium Frame

Premium Cab

FIGURE 1 - EC-60™ CONTROLLERS

INTRODUCTION

Bendix® EC-60™ controllers are members of a family of electronic **Antilock Braking System (ABS)** devices designed to help improve the braking characteristics of air braked vehicles - including heavy and medium duty buses, trucks, and tractors. ABS controllers are also known as **Electronic Control Units (ECUs)**.

Bendix ABS uses wheel speed sensors, ABS modulator valves, and an ECU to control either four or six wheels of a vehicle. By monitoring individual wheel turning motion during braking, and adjusting or pulsing the brake pressure at each wheel, the EC-60™ controller is able to optimize slip between the tire and the road surface. When excessive wheel slip, or wheel lock-up, is detected, the EC-60™ controller will activate the Pressure Modulator Valves to simulate a driver pumping the brakes. However, the EC-60™ controller is able to pump the brakes on individual wheels (or pairs of wheels), independently, and with greater speed and accuracy than a driver.

In addition to the ABS function, premium models of the EC-60™ controller provide an **Automatic Traction Control (ATC)** feature. Bendix ATC can improve vehicle traction during acceleration, and lateral stability while driving through curves. ATC utilizes **Engine Torque Limiting (ETL)** where the ECU communicates with the engine's controller and/or **Differential Braking (DB)** where individual wheel brake applications are used to improve vehicle traction.

Premium EC-60™ controllers have a drag torque control feature which reduces driven-axle wheel slip (due to driveline inertia) by communicating with the engine's controller and increasing the engine torque.

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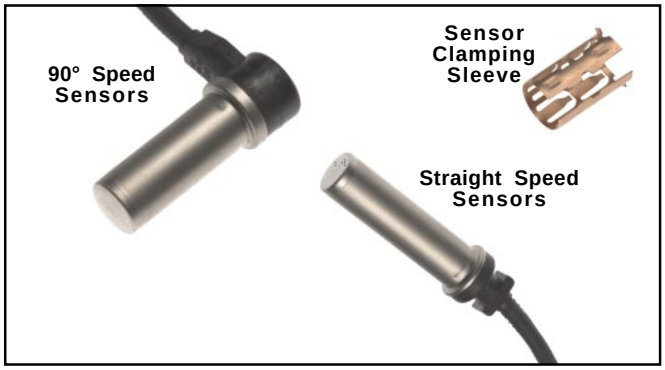


FIGURE 2 - BENDIX® WS-24™ WHEEL SPEED SENSORS

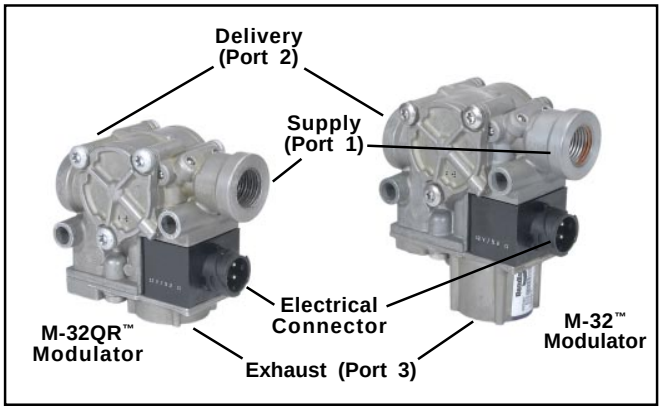


FIGURE 3 - M-32™ AND M-32QR™ MODULATORS

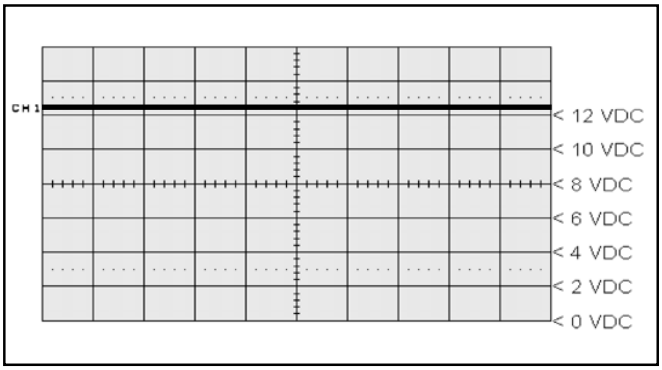


FIGURE 4 - POWER LINE WITHOUT PLC SIGNAL

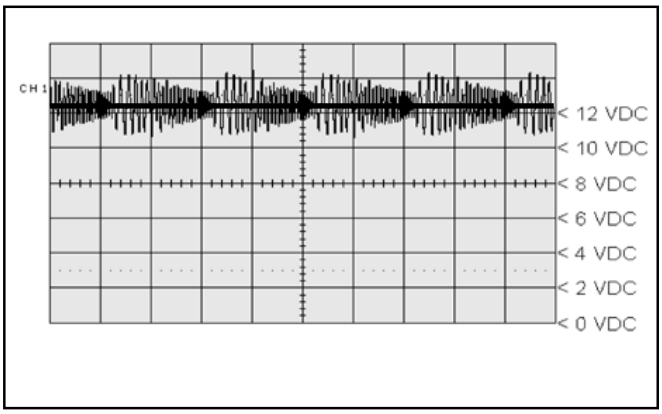


FIGURE 5 - POWER LINE WITH PLC SIGNAL

COMPONENTS

The EC-60™ controller's ABS function utilizes the following components:

- Bendix® WS-24™ wheel speed sensors (4 or 6, depending on ECU model and configuration). Each sensor is installed with a Bendix Sensor Clamping Sleeve
- Bendix® M-32™ or M-32QR™ Pressure Modulator Valves (4, 5, or 6 depending on ECU model and configuration)
- Dash-mounted tractor ABS Indicator Lamp
- Service brake relay valve
- Dash-mounted trailer ABS Indicator Lamp (used on all towing vehicles manufactured after March 1, 2001)
- Optional blink code activation switch
- Optional ABS off-road switch. (Off-road feature is not available on all models - See Chart 1.)

The EC-60™ controller ATC function utilizes the following additional components:

- Traction control valve (may be integral to the service brake relay valve or a stand-alone device)
- Dash-mounted ATC status/indicator lamp
- J1939 serial communication to engine control module
- Stop lamp switch input (may be provided using the ECU hardware input or J1939)
- Optional ATC off-road switch

ECU MOUNTING

Cab ECUs

Cab-mounted EC-60™ controllers are not protected against moisture, and must be mounted in an environmentally protected area.

All wire harness connectors must be properly seated. The use of secondary locks is strongly recommended.

CAUTION: All unused ECU connectors must be covered and receive any necessary protection from moisture, etc.

Cab ECUs utilize connectors from the AMP MCP 2.8 product family.

Frame ECUs

Frame-mounted EC-60™ controllers may be mounted on the vehicle frame, but only in locations where they will not be subjected to direct tire spray. ECU mounting bolts must be torqued to 7.5 to 9 Nm.

CAUTION: The frame wire harness connectors must be properly seated with the seals intact (undamaged). All unused connector terminals must be plugged with the appropriate sealing plugs. Failure to properly seat or seal the connectors could result in moisture or corrosion damage to the connector terminals. ECUs damaged by moisture and/or corrosion are not covered under the Bendix warranty.

Frame ECUs utilize Deutsch connectors.

ECU Model	Mounting	Input Voltage	Sensors	PMVs	ATC	Blink Codes	Serial Communication		PLC	ABS Off-Road	ATC Off-Road	Retarder Relay
							J1587	J1939				
Standard	Cab Frame	12	4	4		✔	✔	✔				✔
Standard PLC	Cab Frame	12	4	4		✔	✔	✔	✔			✔
Premium	Cab Frame	12	4/6	4/5/6	✔	✔	✔	✔	✔	✔	✔	✔
Premium	Cab	24	4/6	4/5/6	✔	✔	✔	✔		✔	✔	✔

CHART 1 - EC-60™ CONTROLLERS AVAILABLE

HARDWARE CONFIGURATIONS

Standard Models

Standard model EC-60™ controllers support four sensor/four modulator (4S/4M) applications. Certain models support Power Line Carrier (PLC) communications, with all models supporting 12 volt installations. *See Chart 1 for more details.*

Premium Models

Premium model EC-60™ controllers support applications up to six sensor/six modulator (6S/6M) installations with ATC and drag torque control. All 12 volt models support PLC. 24 volt models do not support PLC. *See Chart 1 for more details.*

EC-60™ CONTROLLERS WITH PLC

Since March 1, 2001, all towing vehicles must have an in-cab trailer ABS Indicator Lamp. Trailers transmit the status of the trailer ABS over the power line (the blue wire of the J560 connector) to the tractor using a Power Line Carrier (PLC) signal. See Figures 4 and 5. Typically the signal is broadcast by the trailer ABS ECU. The application of PLC technology for the heavy vehicle industry is known as "PLC4Trucks." The Standard PLC EC-60™ controller and the Premium EC-60™ controller (12 volt versions) support PLC communications in accordance with SAE J2497.

Identifying an EC-60™ Controller with PLC

Refer to the information panel on the ECU label to see if the controller provides PLC.

An oscilloscope can be used to measure or identify the presence of a PLC signal on the power line. The PLC signal is an amplitude and frequency modulated signal. Depending on the filtering and load on the power line, the PLC signal amplitude can range from 5.0mVp-p to 7.0 Vp-p. Suggested oscilloscope settings are AC coupling, 1 volt/div, 100 µsec/div. The signal should be measured at the ignition power input of the EC-60™ controller.

Note: An ABS trailer equipped with PLC, or a PLC diagnostic tool, must be connected to the vehicle in order to generate a PLC signal on the power line.

Alternatively, the part number shown on the ECU label can be identified as a PLC or non-PLC model by calling the Bendix TechTeam at 1-800-AIR-BRAKE (1-800-247-2725).

EC-60™ CONTROLLER INPUTS

Battery and Ignition Inputs

The ECU operates at a nominal supply voltage of 12 or 24 volts, depending on the model of the ECU. The battery input is connected through a 30 amp fuse directly to the battery.

The ignition input is applied by the ignition switch through a 5 amp fuse.

Ground Input

The EC-60™ controller supports one ground input. See pages 35 to 40 for system schematics.

ABS Indicator Lamp Ground Input (Cab ECUs Only)

EC-60™ cab ECUs require a second ground input (X1-12) for the ABS indicator lamp. The X1 wire harness connector contains an ABS indicator lamp interlock (X1-15), which shorts the ABS indicator lamp circuit (X1-18) to ground if the connector is removed from the ECU.

Bendix® WS-24™ Wheel Speed Sensors

Wheel speed data is provided to the EC-60™ controller from the WS-24™ wheel speed sensor (see Figure 2). Vehicles have an exciter ring (or "tone ring") as part of the wheel assembly, and as the wheel turns, the teeth of the exciter ring pass the wheel speed sensor, generating an AC signal. The EC-60™ controller receives the AC signal, which varies in voltage and frequency as the wheel speed changes.

Vehicle axle configurations and ATC features determine the number of WS-24™ wheel speed sensors that must be used. A vehicle with a single rear axle requires four wheel speed sensors. Vehicles with two rear axles can utilize six wheel speed sensors for optimal ABS and ATC performance.

Diagnostic Blink Code Switch

A momentary switch that grounds the ABS Indicator Lamp output is used to place the ECU into the diagnostic blink code mode and is typically located on the vehicle's dash panel.

ABS Off-Road Switch and Indicator Lamp Operation

WARNING: The ABS off-road mode should not be used on normal, paved road surfaces because vehicle stability and steerability may be affected. When the ECU is placed in the ABS off-road mode, the ABS Indicator Lamp will flash constantly to notify the vehicle operator that the off-road mode is active.

Premium EC-60™ controllers use a dash-mounted switch to place the ECU into the ABS off-road mode. In some cases, ECUs may also be put into the ABS off-road mode by one of the other vehicle control modules, using a J1939 message to the EC-60™ controller.

(If you need to know if your EC-60™ controller uses a J1939 message to operate the lamp, e-mail ABS@bendix.com, specifying the ECU part number, or call 1-800-AIR-BRAKE and speak to the Bendix TechTeam.)

Stop Lamp Switch (SLS)

The Premium EC-60™ controller monitors the vehicle stop lamp status. Certain vehicle functions, such as ATC and All-Wheel Drive (AWD), use the status of the stop lamp to know the driver's intention. This can be provided to the ECU via J1939 communications, or hardware input.

EC-60™ CONTROLLER OUTPUTS

Bendix® M-32™ and M-32QR™ Pressure Modulator Valves (PMV)

The Bendix® M-32™ and M-32QR™ pressure modulator valves (PMV) are operated by the EC-60™ controller to modify driver applied air pressure to the service brakes during ABS or ATC activation (See pages 6-8). The PMV is an electro-pneumatic control valve and is the last valve that air passes through on its way to the brake chamber. The modulator hold and release solenoids are activated to precisely modify the brake pressure during an antilock braking event. The hold solenoid is normally open and the release solenoid is normally closed.

Traction Control Valve (TCV)

Premium EC-60™ controllers will activate the TCV during differential braking ATC events. The TCV may be a separate valve or integrated into the rear axle relay valve.

ABS Indicator Lamp Control with Optional Diagnostic Blink Code Switch (Cab and Frame ECUs)

Cab and frame-mount EC-60™ controllers have internal circuitry to control the ABS Indicator Lamp on the dash panel.

The ABS Lamp Illuminates:

1. During power up (e.g. when the vehicle is started) and turns off after the self test is completed, providing no **Diagnostic Trouble Codes (DTCs)** are present on the tractor.
2. If the ECU is unplugged or has no power.
3. When the ECU is placed into the ABS off-road mode (the lamp flashes rapidly).
4. To display blink codes for diagnostic purposes after the external diagnostic switch is activated.

Certain models of the EC-60™ controller communicate with other vehicle control modules to operate the ABS Indicator Lamp using serial communications. (If you need to know if your EC-60™ controller uses serial communications to operate the lamp, e-mail ABS@bendix.com, specifying the ECU part number, or call 1-800-AIR-BRAKE and speak to the Bendix TechTeam.)

Indicator Lamp Control Using Serial Communications Links

As mentioned above, depending on the vehicle manufacturer, the dash indicator lamps (ABS, ATC, and trailer ABS) may be controlled using serial communications links. In these cases, the EC-60™ controller will send a serial communications message over the J1939 or J1587 links indicating the required status of the lamp(s). Another vehicle control module receives the message and controls the indicator lamp(s).

Retarder Relay Disable Output

The retarder relay disable output may be used to control a retarder disable relay.

When configured to use this output, the ECU will energize the retarder disable relay and inhibit the use of the retarder as needed.

SAE J1939 Serial Communications

A Controller Area Network (CAN) data link (SAE J1939) is provided for communication. This link is used for various functions, such as:

- To disable retarding devices during ABS operation
- To request torque converter lock-up during ABS operation
- To share information such as wheel speed and ECU status with other vehicle control modules

Premium EC-60™ controllers utilize the J1939 data link for ATC and drag torque control functions.

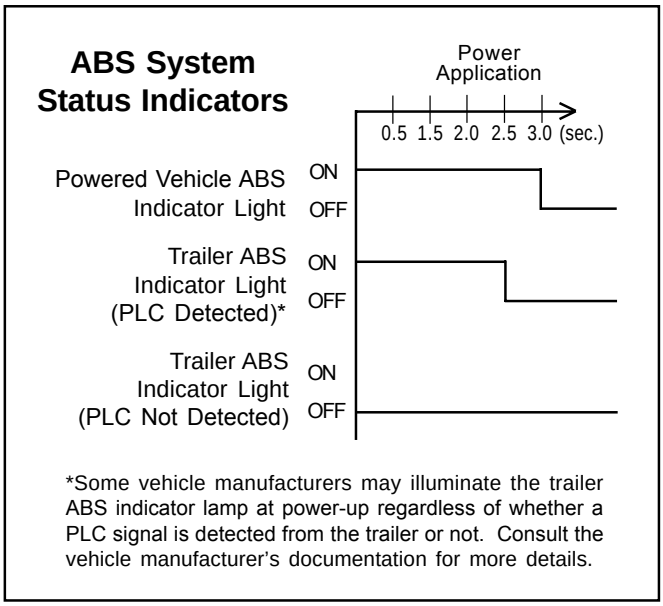


FIGURE 6 - ABS DASH LIGHTS START UP SEQUENCE

Trailer ABS Indicator Lamp Control

Certain models of the EC-60™ controller activate a trailer ABS Indicator Lamp (located on the dash panel) that indicates the status of the trailer ABS unit on one, or more trailers, or dollies. Typically, the EC-60™ controller directly controls the trailer ABS Indicator Lamp based on the information it receives from the trailer ABS.

Alternatively, some vehicles require the EC-60™ controller to activate the trailer ABS Indicator Lamp by communicating with other vehicle controllers using serial communications. (If you need to know if your EC-60™ controller uses a serial communications message to operate the lamp, e-mail ABS@bendix.com, specifying the ECU part number, or call 1-800-AIR-BRAKE and speak to the Bendix TechTeam.)

SAE J1708/J1587 Serial Communications

An SAE J1708 data link, implemented according to SAE J1587 recommended practice, is available for diagnostic purposes, as well as ECU status messages.

ATC Lamp Output/ATC Off-Road Switch Input

Premium ECUs control the ATC dash lamp.

The ATC Lamp Illuminates:

1. During power up (e.g. when the vehicle is started) and turns off after the self test is completed, providing no diagnostic trouble codes are present.
2. When ATC is disabled for any reason.
3. During an ATC event (the lamp will flash rapidly).
4. When the ECU is placed in the ATC off-road mode (the lamp will flash slowly at a rate of 1.0 seconds on, 1.5 seconds off). This notifies the vehicle operator that the off-road mode is active.

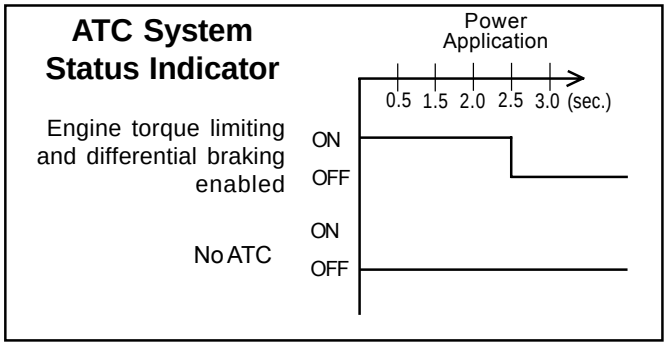


FIGURE 7 - ATC INDICATOR LIGHT START UP SEQUENCE

Interaxle Differential Lock Control (AWD Transfer Case)
Premium ECUs can control the interaxle differential lock (AWD transfer case). This is recommended on AWD vehicles, but the ECU must be specially configured to provide this feature. E-mail to ABS@bendix.com for more details.

POWER-UP SEQUENCE

WARNING: The vehicle operator should verify proper operation of all installed indicator lamps (ABS, ATC, and trailer ABS) when applying ignition power and during vehicle operation.

Lamps that do not illuminate as required when ignition power is applied, or remain illuminated after ignition power is applied, indicate the need for maintenance.

ABS Indicator Lamp Operation

The ECU will illuminate the ABS Indicator Lamp for approximately three seconds when ignition power is applied, after which the lamp will extinguish if no diagnostic trouble codes are detected.

The ECU will illuminate the ABS Indicator Lamp whenever full ABS operation is not available due to a diagnostic trouble code. In most cases, partial ABS is still available.

ATC Status/Indicator Lamp Operation

The ECU will illuminate the ATC lamp for approximately 2.5 seconds when ignition power is applied, after which the lamp will extinguish, if no diagnostic trouble codes are detected.

The ECU will illuminate the ATC Indicator Lamp whenever ATC is disabled due to a diagnostic trouble code.

Trailer ABS Indicator Lamp Operation

Certain models of the ECU will control the Trailer ABS Indicator Lamp when a PLC signal (SAE J2497) from a trailer ABS ECU is detected.

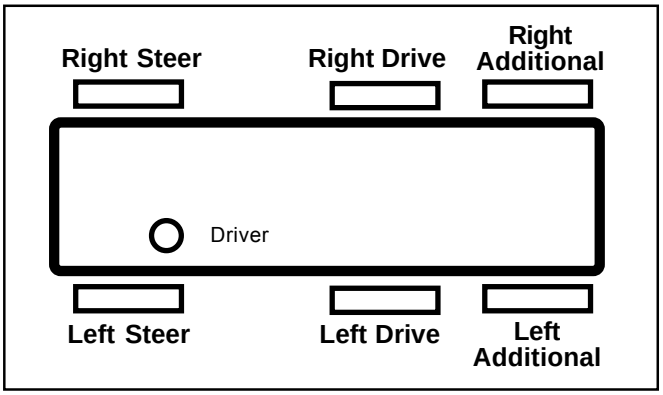


FIGURE 8 - VEHICLE ORIENTATION (TYPICAL)

ECU Configuration Test

Within two seconds of the application of ignition power, the ECU will perform a test to detect system configuration with regards to the number of wheel speed sensors and PMVs. This can be audibly detected by a rapid cycling of the PMVs. (Note: The ECU will not perform the configuration test when wheel speed sensors show that the vehicle is in motion.)

Pressure Modulator Valve Chuff Test

After the performance of the configuration test, the EC-60™ controller will perform a Bendix-patented PMV Chuff Test. The Chuff Test is an electrical and pneumatic PMV test that can assist maintenance personnel in verifying proper PMV wiring and installation.

With brake pressure applied, a properly installed PMV will perform one sharp audible exhaust of air by activating the hold solenoid twice and the release solenoid once. If the PMV is wired incorrectly, it will produce two exhausts of air or none at all.

The EC-60™ controller will perform a PMV chuff test on all installed modulators in the following order:

- Steer Axle Right PMV
- Steer Axle Left PMV
- Drive Axle Right PMV
- Drive Axle Left PMV
- Additional Axle Right PMV
- Additional Axle Left PMV

The pattern will then repeat itself.

The ECU will not perform the PMV Chuff Test when wheel speed sensors show that the vehicle is in motion.

ABS OPERATION

Bendix ABS uses wheel speed sensors, ABS modulator valves, and an ECU to control either four or six wheels of a vehicle. By monitoring individual wheel turning motion during braking, and adjusting or pulsing the brake pressure at each wheel, the EC-60™ controller is able to optimize slip between the tire and the road surface. When excessive wheel slip, or wheel lock-up, is detected, the EC-60™ controller will activate the Pressure Modulator Valves to simulate a driver pumping the brakes. However, the EC-60™ controller is able to pump the brakes on individual wheels (or pairs of wheels), independently, and with greater speed and accuracy than a driver.

Steer Axle Control

Although both wheels of the steer axle have their own wheel speed sensor and pressure modulator valve, the EC-60™ controller blends the applied braking force between the two steering axle brakes. This Bendix patented brake application control, called Modified Individual Regulation (MIR), is designed to help reduce steering wheel pull during an ABS event on road surfaces with poor traction (or areas of poor traction, e.g. asphalt road surfaces with patches of ice).

Single Drive Axle Control (4x2 Vehicle)

For vehicles with a single rear drive axle (4x2), the brakes are operated independently by the EC-60™ controller, based on the individual wheel behavior.

Dual Drive Axle Control (4S/4M Configuration)

For vehicles with dual drive axles (6x4) using a 4S/4M configuration, one ABS modulator controls both right-side rear wheels and the other modulator controls both left-side rear wheels. Both wheels on each side receive equal brake pressure during an ABS stop. The rear wheel speed sensors must be installed on the axle with the lightest load.

Dual Rear Axle Control (6S/6M Configuration)

For vehicles with dual rear axles (6x4, 6x2) using a 6S/6M configuration, the rear wheels are controlled independently. Therefore, brake application pressure at each wheel is adjusted according to the individual wheel behavior on the road surface.

6x2 Vehicles with 6S/5M Configuration

6x2 vehicles can utilize a 6S/5M configuration, with the additional axle (a non-driven rear axle) having two sensors, but only one Pressure Modulator Valve. In this case, the PMV controls both wheels on the additional axle. The additional axle wheels would receive equal brake pressure, based on the wheel that is currently experiencing the most wheel slip.

Normal Braking

During normal braking, brake pressure is delivered through the ABS PMV and into the brake chamber. If the ECU does not detect excessive wheel slip, it will not activate ABS control, and the vehicle stops with normal braking.

Retarder Brake System Control

On surfaces with low traction, application of the retarder can lead to high levels of wheel slip at the drive axle wheels, which can adversely affect vehicle stability.

To avoid this, the EC-60™ controller switches off the retarder as soon as a lock-up is detected at one (or more) of the drive axle wheels.

When the ECU is placed in the ABS off-road mode, it will switch off the retarder only when ABS is active on a steer axle wheel and a drive axle wheel.

Optional ABS Off-Road Mode

On some road conditions, particularly when the driving surface is soft, the stopping distance with ABS may be longer than without ABS. This can occur when a locked wheel on soft ground plows up the road surface in front of the tire, changing the rolling friction value. Although vehicle stopping distance with a locked wheel may be shorter than corresponding stopping distance with ABS control, vehicle steerability and stability is reduced.

Premium EC-60™ controllers have an optional control mode that more effectively accommodates these soft road conditions to shorten stopping distance while maintaining optimal vehicle steerability and stability.

WARNING: The ABS off-road mode should not be used on normal, paved road surfaces because vehicle stability and steerability may be reduced. The flashing ABS Indicator Lamp communicates the status of this mode to the driver.

The vehicle manufacturer should provide the optional ABS off-road function only for vehicles that operate on unpaved surfaces or that are used in off-road applications, and is responsible for insuring that vehicles equipped with the ABS off-road function meet all FMVSS-121 requirements and have adequate operator indicators and instructions.

The vehicle operator activates the off-road function with a switch on the dash panel. A flashing ABS Indicator Lamp indicates to the driver that the ABS off-road function is engaged. To exit the ABS off-road mode, depress and release the switch.

All-Wheel Drive (AWD) Vehicles

AWD vehicles with an engaged interaxle differential (steer axle to rear axle)/AWD transfer case may have negative effects on ABS performance. Optimum ABS performance is achieved when the lockable differentials are disengaged, allowing individual wheel control.

Premium EC-60™ controllers can be programmed specifically for this configuration to control the differential lock/unlock solenoid in the AWD transfer case. When programmed to do so, the ECU will disengage the locked interaxle/AWD transfer case during an ABS event and reengage it once the ABS event has ended.

ATC OPERATION

ATC Functional Overview

Just as ABS improves vehicle stability during braking, ATC improves vehicle stability and traction during vehicle acceleration. The EC-60™ controller ATC function uses the same wheel speed information and modulator control as the ABS function. The EC-60™ controller detects excessive drive wheel speed, compares the speed of the front, non-driven wheels, and reacts to help bring the wheel spin under control. The EC-60™ controller can be configured to use engine torque limiting and/or differential braking to control wheel spin. For optimal ATC performance, both methods are recommended.

ATC Lamp Operation

The ATC Lamp Illuminates:

1. During power up (e.g. when the vehicle is started) and turns off after the self test is completed, providing no diagnostic trouble codes are present.
2. When ATC is disabled for any reason.
3. During an ATC event (the lamp will flash rapidly). When ATC is no longer active, the ATC active/indicator lamp turns off.
4. When the ECU is placed in the ATC off-road mode (the lamp will flash at a rate of 1.0 seconds on, 1.5 seconds off). This notifies the vehicle operator that the off-road mode is active.

Differential Braking

Differential braking is automatically activated when drive wheel(s) on one side of the vehicle are spinning, which typically occur on asphalt road surfaces with patches of ice. The traction system will then lightly apply the brake to the drive wheel(s) that are spinning. The vehicle differential will then drive the wheels on the other side of the vehicle.

Differential braking is available at vehicle speeds up to 25 MPH.

Disabling ATC Differential Braking

ATC differential braking is disabled under the following conditions:

1. During power up (e.g. when the vehicle is started), until the ECU detects a service brake application.
2. If the ECU receives a J1939 message indicating that the vehicle is parked.
3. When the dynamometer test mode is active. The dynamometer test mode is entered using the diagnostic blink code switch or by using a diagnostic tool (such as Bendix® ACom™ Diagnostics).

4. In response to a serial communications request from a diagnostic tool.
5. During brake torque limiting to avoid overheating of the brakes.
6. When certain diagnostic trouble code conditions are detected.

Engine Torque Limiting (ETL) with *Smart ATC*™ Traction Control

The EC-60™ controller uses Engine Torque Limiting to control drive axle wheel slip. This is communicated to the engine control module (using J1939), and is available at all vehicle speeds.

Bendix® *Smart ATC*™ Traction Control

The EC-60™ controller has an additional feature known as *Smart ATC*™ traction control. *Smart ATC*™ traction control monitors the accelerator pedal position (using J1939) to help provide optimum traction and vehicle stability. By knowing the driver's intention and adapting the target slip of the drive wheels to the driving situation, the *Smart ATC*™ traction control allows higher wheel slip when the accelerator pedal is applied above a preset level.

The target wheel slip is decreased when driving through a curve for improved stability.

Disabling ATC Engine Control and *Smart ATC*™ Traction Control

ATC Engine Control and *Smart ATC*™ traction control will be disabled under the following conditions:

1. In response to a serial communications request from an off-board tool.
2. At power-up until the ECU detects a service brake application.
3. If the ECU receives a J1939 message indicating that the vehicle is parked.
4. If the dynamometer test mode is active. This may be accomplished via an off-board tool or the diagnostic blink code switch.
5. When certain diagnostic trouble code conditions are detected.

Optional ATC Off-Road Mode

In some road conditions, the vehicle operator may desire additional drive wheel slip when ATC is active. The Premium EC-60™ controller has an optional control mode to permit this desired performance.

The vehicle operator can activate the off-road function with a switch on the dash panel. Alternately, a J1939 message may be used to place the vehicle in this mode. The ATC Indicator Lamp will flash continually to confirm that the off-road ATC function is engaged.

To exit the ATC off-road mode, depress and release the ATC off-road switch.

Drag Torque Control Functional Overview

Premium EC-60™ controllers have a feature referred to as drag torque control which reduces wheel slip on a driven axle due to driveline inertia. This condition is addressed by increasing the engine torque to overcome the inertia.

Drag torque control increases vehicle stability on low-traction road surfaces during down-shifting or retarder braking.

Dynamometer Test Mode

WARNING: ATC must be disabled prior to conducting any dynamometer testing. When the Dynamometer Test Mode is enabled, ATC brake control and engine control along with drag torque control are turned off. This test mode is used to avoid torque reduction or torque increase and brake control activation when the vehicle is operated on a dynamometer for testing purpose.

The Dynamometer Test Mode may be activated by pressing and releasing the diagnostic blink code switch five times or by using a hand-held or PC-based diagnostic tool.

The Dynamometer Test Mode will remain active even if power to the ECU is removed and re-applied. Press and release the blink code switch three times, or use a hand-held or PC-based diagnostic tool to exit the test mode.

Automatic Tire Size Calibration

The ECU requires a precise rolling circumference ratio between steer axle and drive axle tires in order for ABS and ATC to perform in an optimal manner. For this reason, a learning process continuously takes place in which the precise ratio is calculated. This calculated value is stored in the ECU memory provided the following conditions are met:

1. Rolling-circumference ratio is within the permissible range.
2. Vehicle speed is greater than approximately 12 MPH.
3. No acceleration or deceleration is taking place.
4. There are no active speed sensor diagnostic trouble codes.

The ECU is provided with a ratio value of 1.00 as a default setting. If the automatic tire size alignment calculates a different value, this is used to overwrite the original figure in the memory. This process adapts the ABS and ATC function to the vehicle.

Acceptable Tire Sizes

The speed calculation for an exciter ring with 100 teeth is based on a default tire size of 510 revolutions per mile. This figure is based on the actual rolling circumference of the tires, which varies with tire size, tire wear, tire pressure, vehicle loading, etc.

The ABS response sensitivity is reduced when the actual rolling circumference is excessive on all wheels. For a 100 tooth exciter ring, the minimum number of tire revolutions

per mile is 426, and the maximum is 567. The ECU will set diagnostic trouble codes if the number or revolutions are out of this range.

In addition, the size of the steer axle tires compared to the drive axle tires also has to be within the ABS system design. To avoid diagnostic trouble codes, the ratio of the effective rolling circumference of the steer axle, divided by the effective rolling circumference of the drive axle, must be between 0.85 to 1.15.

ABS PARTIAL SHUTDOWN

Depending which component the trouble code is detected on, the ABS and ATC functions may be fully or partially disabled. Even with the ABS indicator lamp on, the EC-60™ controller may still provide ABS function on wheels that are not affected. The EC-60™ controller should be serviced as soon as possible.

Steer Axle ABS Modulator Diagnostic Trouble Code

ABS on the affected wheel is disabled. ABS and ATC on all other wheels remains active.

Drive Axle/Additional Axle ABS Modulator Diagnostic Trouble Code

ATC is disabled. ABS on the affected wheel is disabled. ABS on all other wheels remains active.

Steer Axle Wheel Speed Sensor Diagnostic Trouble Code

The wheel with the diagnostic trouble code is still controlled by using input from the remaining wheel speed sensor on the front axle. ABS remains active on the rear wheels. ATC is disabled.

Drive Axle/Additional Axle Wheel Speed Sensor Diagnostic Trouble Code

ATC is disabled. In a four sensor system, ABS on the affected wheel is disabled, but ABS on all other wheels remains active.

In a six sensor system, ABS remains active by using input from the remaining rear wheel speed sensor on the same side.

ATC Modulator Diagnostic Trouble Code

ATC is disabled. ABS remains active.

J1939 Communication Diagnostic Trouble Code

ATC is disabled. ABS remains active.

ECU Diagnostic Trouble Code

ABS and ATC are disabled. The system reverts to normal braking.

Voltage Diagnostic Trouble Code

While voltage is out of range, ABS and ATC are disabled. The system reverts to normal braking. When the correct voltage level is restored, full ABS and ATC function is available. Operating voltage range is 9.0 to 17.0 VDC.

Reconfiguring EC-60™ Controllers

SYSTEM CONFIGURATION

The EC-60™ controller is designed to allow the technician to change the default system settings (chosen by the vehicle OEM) to provide additional or customized features. When replacing an ECU, be sure to use an equivalent Bendix replacement part number so that the standard default settings are provided.

Depending on the model, the customizable features include ABS control settings, engine module communication etc. Many of these settings can be reconfigured using a hand-held or PC-based software, such as the Bendix® ACom™ Diagnostics program.

ECU RECONFIGURATION

Reconfiguring Standard ECUs

Reconfigurating an EC-60™ controller may be carried out by using the Blink Code Switch or by using a hand-held or PC-based diagnostic tool.

Note: During the reconfiguration process, and independently from any reconfiguration being carried out by the technician, standard ECUs automatically check the J1939 serial link and communicate with other vehicle modules. In particular, if the serial link shows that the vehicle has a retarder device present, the ECU will configure itself to communicate with the retarder device for improved ABS performance. For example, if the ECU detects the presence of a retarder disable relay during a reconfiguration, it will configure itself to control the relay to disable the retarding device as needed.

Reconfiguring Premium ECUs

As with standard ECUs, the Premium EC-60™ controller also carries out, independently from any reconfiguration being carried out by the technician, an automatic check of the J1939 serial link and communicate with other vehicle modules. This includes checking for ATC and retarder disable relay operation. In addition, premium EC-60™ controllers will determine the number of wheel speed sensors and PMVs installed and configure itself accordingly.

6S/5M Configuration

Premium EC-60™ controllers will configure for 6S/5M operation when a reconfiguration event is initiated and the ECU detects that an additional axle PMV is wired as follows:

PMV Connector	ECU Connector
Hold	Right Additional Axle Hold
Release	Left Additional Axle Release
Common	Right Additional Axle Common

See 6S/5M System Schematics (pages 37 & 40) for details.

Reconfiguration Using the Blink Code Switch

The reconfiguration event is the same for both Standard and Premium ECUs. With ignition power removed from the EC-60™ controller, depress the blink code switch. After the ignition power is activated, depress and release the switch seven times to initiate a reconfiguration event.

Diagnostic Tool

A reconfiguration event may be initiated using a hand-held or PC-based diagnostic tool to communicate with the ECU over the SAE J1587 diagnostic link.

Troubleshooting: General

SAFE MAINTENANCE PRACTICES

WARNING! PLEASE READ AND FOLLOW THESE INSTRUCTIONS TO AVOID PERSONAL INJURY OR DEATH:

When working on or around a vehicle, the following general precautions should be observed at all times:

1. **Park the vehicle on a level surface, apply the parking brakes, and always block the wheels. Always wear safety glasses.**
2. **Stop the engine and remove ignition key when working under or around the vehicle. When working in the engine compartment, the engine should be shut off and the ignition key should be removed. Where circumstances require that the engine be in operation, EXTREME CAUTION should be used to prevent personal injury resulting from contact with moving, rotating, leaking, heated or electrically charged components.**
3. **Do not attempt to install, remove, disassemble or assemble a component until you have read and thoroughly understand the recommended procedures. Use only the proper tools and observe all precautions pertaining to use of those tools.**
4. **If the work is being performed on the vehicle's air brake system, or any auxiliary pressurized air systems, make certain to drain the air pressure from all reservoirs before beginning ANY work on the vehicle. If the vehicle is equipped with an AD-IS® air dryer system or a dryer reservoir module, be sure to drain the purge reservoir.**
5. **Following the vehicle manufacturer's recommended procedures, deactivate the electrical system in a manner that safely removes all electrical power from the vehicle.**
6. **Never exceed manufacturer's recommended pressures.**
7. **Never connect or disconnect a hose or line containing pressure; it may whip. Never remove a component or plug unless you are certain all system pressure has been depleted.**
8. **Use only genuine Bendix® replacement parts, components and kits. Replacement hardware, tubing, hose, fittings, etc. must be of equivalent size, type and strength as original equipment and be designed specifically for such applications and systems.**
9. **Components with stripped threads or damaged parts should be replaced rather than repaired. Do not attempt repairs requiring machining or welding unless specifically stated and approved by the vehicle and component manufacturer.**
10. **Prior to returning the vehicle to service, make certain all components and systems are restored to their proper operating condition.**
11. **For vehicles with Antilock Traction Control (ATC), the ATC function must be disabled (ATC indicator lamp should be ON) prior to performing any vehicle maintenance where one or more wheels on a drive axle are lifted off the ground and moving.**

REMOVING THE EC-60™ CONTROLLER ASSEMBLY

1. Turn vehicle ignition off.
2. Remove as much contamination as possible prior to disconnecting air lines and electrical connections.
3. Note the EC-60™ controller assembly mounting position on the vehicle.
4. Disconnect the electrical connectors from the EC-60™ controller.
5. Remove and retain the mounting bolts that secure the EC-60™ controller.

INSTALLING A NEW EC-60™ CONTROLLER

CAUTION! When replacing the EC-60™ controller, verify that the unit you are installing has the correct default settings. Failure to do so could result in a loss of features, such as ATC and PLC, or noncompliance with U.S. regulations such as FMVSS 121. It is recommended to use only the correct replacement part number. However, most configuration settings can be altered using the Bendix ACom™ ABS Diagnostic Software program.

Verify correct operation of the EC-60™ controller system and indicator lamps prior to putting the vehicle back into service. Towing vehicles manufactured after March 1, 2001 must support the trailer ABS indicator lamp located on the dash.

For further information, contact either the vehicle manufacturer, Bendix or your local authorized Bendix dealer.

1. Position and secure the EC-60™ controller in the original mounting orientation using the mounting bolts retained during removal. On frame-mount ECUs, torque the mounting bolts to 7.5 to 9 NM (66-80 in. lbs). For cab-mount units use no more torque than is necessary to firmly secure the ECU into position. Over-tightening the mounting hardware can cause damage to the EC-60™ controller.
2. Reconnect the electrical connectors to the EC-60™ controller.
3. Apply power and monitor the EC-60™ controller power-up sequence to verify proper system operation.

See Troubleshooting: Wiring section beginning on page 32 for more information on wire harnesses.

Troubleshooting: Blink Codes and Diagnostic Modes

ECU DIAGNOSTICS

The EC-60™ controller contains self-testing diagnostic circuitry that continuously checks for the normal operation of internal components and circuitry, as well as external ABS components and wiring.

Active Diagnostic Trouble Codes

When an erroneous system condition is detected, the EC-60™ controller:

1. Illuminates the appropriate indicator lamp(s) and disengages part or all of the ABS and ATC functions. (See page 9.)
2. Places the appropriate trouble code information in the ECU memory.
3. Communicates the appropriate trouble code information over the serial communications diagnostic link as required. Hand-held or PC-based diagnostic tools attach to the vehicle diagnostic connector, typically located on or under the dash (see Figure 9).

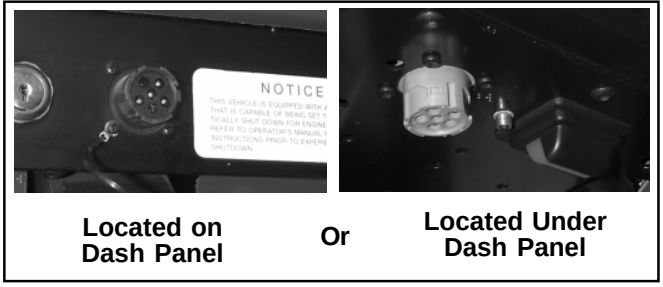


FIGURE 9 - TYPICAL VEHICLE DIAGNOSTIC CONNECTOR LOCATIONS (J1708/J1587, J1939)

BLINK CODES

Blink codes allow a technician to troubleshoot ABS problems without using a hand-held or PC-based diagnostic tool. Instead, information about the ABS system is communicated by the ECU using the ABS indicator lamp to display sequences of blinks.

Note: The ECU will not enter the diagnostic blink code mode if the wheel speed sensors show that the vehicle is in motion. If the ECU is in the diagnostic blink code mode and then detects vehicle motion, it will exit the blink code mode.

In addition, by operating the blink code switch as described below, one of several diagnostic modes can be entered. See Diagnostic Modes below.

Blink Code Switch Activation

When activating the blink code switch:

1. Wait at least two seconds after “ignition on.” (Except when entering Reconfiguration Mode - see Reconfiguration section on page 10)
2. For the ECU to recognize that the switch is activated “on,” the technician must press for at least 0.1 seconds, but less than 5 seconds. (If the switch is held for more than 5 seconds, the ECU will register a malfunctioning switch.)
3. Pauses between pressing the switch when a sequence is required, (e.g. when changing mode) must not be longer than 2 seconds.
4. After a pause of 3.5 seconds, the ECU will begin responding with output information blinks. See Figure 10 for an example.

Blink Code Timing

The ECU responds with a sequence of blink codes. The overall blink code response from the ECU is called a “message.” Each message includes, depending on the

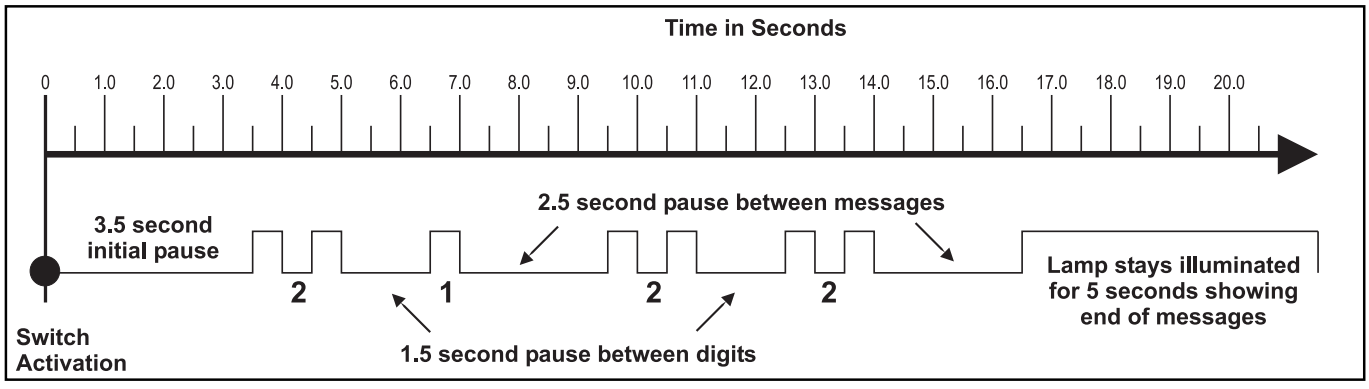


FIGURE 10 - EXAMPLE OF BLINK CODE MESSAGE

mode selected by the technician, a sequence of one or more groups of blinks. Simply record the number of blinks for each sequence and then use the troubleshooting index on page 17 for active or inactive trouble codes and you will be directed to the page that provides troubleshooting information.

NOTE:

1. Sequences of blinks illuminate the ABS indicator lamp for half a second, with half-second pauses between them.
2. Pauses between blink code digits are 1.5 seconds.
3. Pauses between blink code messages are 2.5 seconds.
4. The lamp remains on for 5 seconds at the end of messages.

Once the ABS indicator lamp begins displaying a sequence of codes, it continues until all blink code messages have been displayed and then returns to the normal operating mode. During this time, the ECU will ignore any additional blink code switch activation.

All trouble codes, with the exception of voltage and J1939 trouble codes, will remain in an active state for the remainder of the power cycle.

Voltage trouble codes will clear automatically when the voltage returns within the required limits. All ABS functions will be re-engaged.

J1939 trouble codes will clear automatically when communications are re-established.

DIAGNOSTIC MODES

In order to communicate with the ECU, the controller has several modes that the technician can select, allowing information to be retrieved, or other ECU functions to be accessed.

Diagnostic Modes

To enter the various diagnostic modes:

No. of Times to Press the Blink Code Switch	System Mode Entered
1	Active diagnostic trouble code retrieval
2	Inactive diagnostic trouble code retrieval
3	Clear active diagnostic trouble codes
4	System configuration check
5	Dynamometer Test Mode
7*	Reconfigure ECU

***** To enter the Reconfiguration Mode, the switch must be held in before the application of ignition power. Once the power is supplied, the switch is released and then pressed seven times.

CHART 2 - DIAGNOSTIC MODES

Active Diagnostic Trouble Code Mode

For troubleshooting, typically the Active and Inactive Diagnostic Trouble Retrieval Modes are used. The technician presses the blink code switch once and the ABS indicator lamp flashes a first group of two codes, and if there are more trouble codes recorded, this is followed by a second set of codes, etc. (See page 17 for a directory of these codes.) All active trouble codes may also be retrieved using a hand-held or PC-based diagnostic tool, such as the Bendix® ACom™ Diagnostics software.

To clear active diagnostic trouble codes (as problems are fixed), simply clear (or “self-heal”) by removing and re-applying ignition power. The only exception is for wheel speed sensor trouble codes, which clear when power is removed, re-applied, and the ECU detects valid wheel speed from all wheel speed sensors. Alternately, codes may be cleared by pressing the diagnostic blink code switch 3 times (to enter the Clear Active Diagnostic Trouble Code Mode) or by using a hand-held or PC-based diagnostic tool. Hand-held or PC-based diagnostic tools are able to clear wheel speed sensor trouble codes without the vehicle being driven.

Inactive Diagnostic Trouble Code Mode

The ECU stores past trouble codes and comments (such as configuration changes) in its memory. This record is commonly referred to as “event history.” When an active trouble code is cleared, the ECU stores it in the event history memory as an inactive trouble code.

Using blink codes, the technician may review all inactive trouble codes stored on the ECU. The ABS indicator lamp will display inactive diagnostic blink codes when the diagnostic blink code switch is depressed and released two times. See page 17 for the index showing trouble codes and the troubleshooting guide page to read for help.

Inactive trouble codes, and event history, may be retrieved and cleared by using a hand-held or PC-based diagnostic tool, such as the Bendix® ACom™ Diagnostics software.

Clearing Active Diagnostic Trouble Codes

The ECU will clear active trouble codes when the diagnostic blink code switch is depressed and released three times.

System Configuration Check Mode

The ABS indicator lamp will display system configuration information when the diagnostic blink code switch is depressed and released four times. The lamp will blink out configuration information codes using the following patterns. (See Chart 3). In this mode the ECU tells the technician, by means of a series of six blink codes, the type of ABS system that the ECU has been set up to expect. For example, if the fourth blink code is a three, the technician knows that a 6S/5M sensor/modulator configuration has been set.

Dynamometer Test Mode

The Dynamometer Test Mode is used to disable ATC when needed (e.g. when performing any vehicle maintenance where the wheels are lifted off the ground and moving, including dyno testing). This mode is not reset by power off, power on, cycling. Instead a hand-held or PC-based diagnostic tool must be used to change the setting. Alternatively, depressing and releasing the blink code switch three times will cause the ECU to exit the blink code mode.

Reconfigure ECU Mode

Vehicle reconfiguration is carried out by using the Reconfigure ECU Mode. (See page 10.) Note: To enter the Reconfiguration Mode, the blink code switch must be held in before the application of ignition power. Once the power is supplied, the switch is released and then pressed seven times.

1st Number	System Power
1	12 Volts
2	24 Volts
2nd Number	**Wheel Speed Sensors**
4	4 Sensors
6	6 Sensors
3rd Number	**Pressure Modulator Valves**
4	4 Modulators
5	5 Modulators
6	6 Modulators
4th Number	**ABS Configuration**
1	4S/4M or 6S/6M
2	6S/4M
3	6S/5M
5th Number	**Traction Control Configuration**
2	No ATC
3	ATC Engine Control Only
4	ATC Brake Control Only
5	Full ATC (Engine Control & Brake Control)
6th Number	**Retarder Configuration**
1	No Retarder
2	J1939 Retarder
3	Retarder Relay
4	J1939 Retarder, Retarder Relay

CHART 3 - SYSTEM CONFIGURATION CHECK

Troubleshooting: Using Hand-Held or PC-Based Diagnostic Tools

USING HAND-HELD OR PC-BASED DIAGNOSTICS

Troubleshooting and diagnostic trouble code clearing (as well as reconfiguration) may also be carried out using hand-held or PC-based diagnostic tools such as the Bendix® Remote Diagnostic Unit (RDU™), Bendix® ACom™ Diagnostics software, or the ProLink tool.

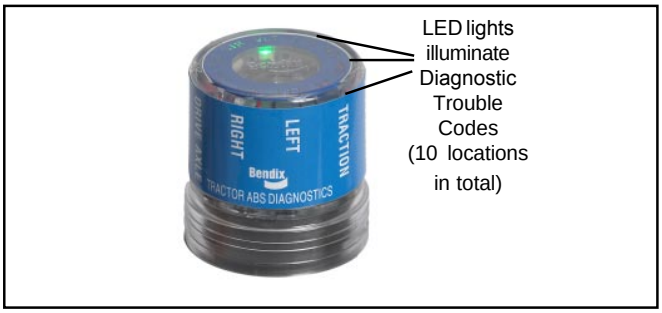


FIGURE 11 - *THE BENDIX® REMOTE DIAGNOSTIC UNIT*

Bendix® RDU™ (Remote Diagnostic Unit)

The Bendix® RDU™ tool provides the technician with a visual indication of Antilock Braking System (ABS) component **Diagnostic Trouble Code (DTC)** information. The RDU™ tool is specifically designed for use with Bendix® ABS systems and Bendix makes no claims for its operation and/or usability with other brands of ABS systems.

Features of the Bendix® RDU™ Tool

The RDU™ tool attaches to the 9 pin diagnostic connector in the cab of the vehicle. An adapter cable (Bendix part number 5012793) is available to connect the RDU to vehicles with a 6-pin diagnostic connector. (See Figure 11.)

The RDU™ tool allows the technician to:

- Troubleshoot ABS system component problems using Diagnostic Trouble Code reporting via LEDs.
- Reset Diagnostic Trouble Codes on Bendix® ABS ECUs by holding a magnet over the reset in center of RDU™ tool for less than 6 seconds.
- Enter the Self-Configuration Mode used by Bendix® ABS ECUs by holding a magnet over the reset area for greater than 6 seconds but less than 30 seconds.

How the Bendix® RDU™ Operates

See Figure 9 for typical vehicle connector locations.

When the RDU™ tool is plugged into the diagnostic connector, all the LEDs will illuminate, and the green LED will flash 4 times to indicate communications have been established.

If the ABS ECU has no active Diagnostic Trouble Codes, only the green LED will remain illuminated.

If the ABS ECU has at least one active Diagnostic Trouble Code the RDU™ tool displays the first diagnostic trouble code by illuminating the red LEDs, indicating the malfunctioning ABS component and its location on the vehicle. (See Figure 11.) If there are multiple diagnostic trouble codes on the ABS system, the RDU™ tool will display one diagnostic trouble code first, then once that Diagnostic Trouble Code has been repaired and cleared, the next code will be displayed.

Typical Combination Diagnostic Trouble Codes are:

- Right steer sensor
- Left steer sensor
- Right drive sensor
- Left drive sensor
- Right additional sensor
- Left additional sensor
- Right steer modulator
- Left steer modulator
- Right drive modulator
- Left drive modulator
- Right additional modulator
- Left additional modulator
- Traction modulator
- ECU
- Engine serial communication
- MOD red LED illuminated, shows the "Common" connection of one or more modulators is shorted to battery or ground
- VLT (Flashing indicates either over- or under-voltage condition)

To pinpoint the root cause and to ensure the system diagnostic trouble code is properly corrected the first time, additional troubleshooting may be necessary.

Bendix® RDU™ Reset Function

The magnetic reset switch is located in the center top of the RDU™ tool. Activation requires a magnet with 30 gauss minimum.

The reset operations are:

1. If the magnet is held over the switch for less than 6 seconds the "clear diagnostic trouble codes" command is sent.
2. If the magnet is held over the switch for more than 6 seconds, but less than 30 seconds, the Bendix® ABS "self-configuration command" is sent.

Additionally, it is recommended at the end of any inspection that the user switches off and restores the power to the ABS ECU, then check the ABS Indicator Lamp operation and RDU™ tool to see if they indicate any remaining Diagnostic Trouble Codes.

LED Diagnostic Trouble Codes

LFT -	Left	ECU -	ABS Controller
RHT -	Right	SEN -	Wheel Speed Sensor
DRV -	Drive Axle		
ADD -	Additional	MOD -	Pressure Modulator Valve
STR -	Steer Axle		
VLT -	Power	TRC -	Traction Control

Example: If the Diagnostic Trouble Code is "Right Steer Axle Sensor", the RDU™ unit will display one green and three red LEDs

LEDs
Green
VLT
Red
SEN
STR
RHT

***FIGURE 12** - DIAGNOSTIC TROUBLE CODES*

Bendix® RDU™ Communication Problems

If the ABS ECU does not respond to the RDU™ tool's request for diagnostic trouble codes, the RDU™ tool will illuminate each red LED in a clockwise pattern. This pattern indicates the loss of communication and will continue until the ABS ECU responds and communication has been established.

Possible sources of communication problems are:

1. A problem with the J1587 link at the in-cab off-board diagnostic connector (9 or 6 Pin).
2. The ECU does not support PID194.
3. No power is being supplied to the ECU and/or the diagnostic connector.
4. The J1587 bus is overloaded with information and the RDU can not arbitrate access.
5. A malfunctioning RDU™ tool.

Nexiq Bendix Application Card

Nexiq provides a Bendix application card for use with the ProLink tool. It can also be used to diagnose the EC-30™, EC-17™, Gen 4™ and Gen 5™, and MC-30™ ABS Controllers. For more information on the Bendix application card visit www.bendix.com, Nexiq at www.nexiq.com, or your local authorized Bendix parts outlet.

Pro-Link

Heavy Duty
Multi Protocol
Cartridge

PC Card MPSI
Part Number
805013

FIGURE 13 - NEXIQ (MPSI) PRO-LINK TOOL

FIGURE 14 - BENDIX® ACOM™ DIAGNOSTICS

Bendix® ACom™ Diagnostics 3.0 Software

Bendix® ACom™ Diagnostics is a PC-based software program and is designed to meet RP-1210 industry standards. This software provides the technician with access to all the available ECU diagnostic information and configuration capability, including:

- ECU information
- Diagnostic trouble codes and repair information
- Configuration (ABS, ATC, and more)
- Wheel speed information
- Perform component tests
- Save and print information

When using ACom™ Diagnostics software to diagnose the EC-60 ABS ECU, the computer's serial or parallel port needs to be connected to the vehicle's diagnostic connector.

For more information on ACom™ Diagnostics software or RP1210 compliant tools, go to www.bendix.com or visit your local authorized Bendix parts outlet.

See Page 42 for Appendix A: J1587 SID and FMI codes and their Bendix blink code equivalents

www.bendix.com

Visit Bendix online for the latest information, and ways to find the Bendix contacts you need. Contact technical support, service engineers, Bendix account managers, and more — www.bendix.com is your complete Bendix resource.

Bendix Technical Assistance Team

For direct telephone technical support, call the Bendix technical assistance team at:

1-800-AIR-BRAKE (1-800-247-2725),

Monday through Friday, 8:00 A.M. to 6:00 P.M. EST, and follow the instructions in the recorded message.

Or, you may e-mail the Bendix technical assistance team at: tbs.techteam@bendix.com.

Active or Inactive Diagnostic Trouble Codes:

INDEX

How to interpret the first digit of messages received when Active or Inactive Diagnostic Trouble Code Mode is entered.

1st Blink Code Number	Go Here for Troubleshooting Tests
1	No faults (1,1)
2	Wheel Speed Sensors - page 18
3	Wheel Speed Sensors - page 18
4	Wheel Speed Sensors - page 18
5	Wheel Speed Sensors - page 18
6	Power Supply - page 23
7	Pressure Modulator Valves - page 20
8	Pressure Modulator Valves - page 20
9	Pressure Modulator Valves - page 20
10	Pressure Modulator Valves - page 20
11	J1939 - page 24
12	Miscellaneous - page 26
13	ECU - page 25
14	Wheel Speed Sensors - page 18
15	Wheel Speed Sensors - page 18
16	Pressure Modulator Valves - page 20
17	Pressure Modulator Valves - page 20
18	Traction Control Valve - page 22

Example: For a message sequence of:

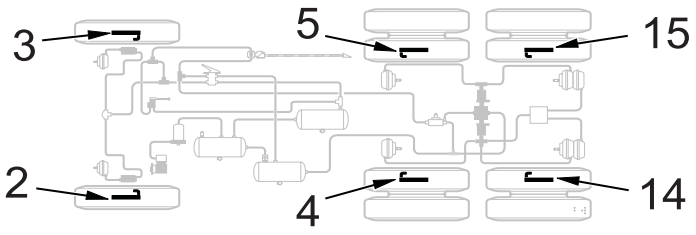
3, 2 12, 4

For the first sequence go to page 18 and for the second sequence go to page 26.

See Page 42 for Appendix A: J1587 SID and FMI Codes and Their Bendix Blink Code Equivalents

Troubleshooting Diagnostic Trouble Codes: Wheel Speed Sensors

1st. Blink Code	Location
2	Left Steer Axle Sensor
3	Right Steer Axle Sensor
4	Left Drive Axle Sensor
5	Right Drive Axle Sensor
14	Left Additional Axle Sensor
15	Right Additional Axle Sensor



2nd. Blink Code	Diagnostic Trouble Code Description	Repair Information
1	Excessive Air Gap	Adjust sensor to contact exciter ring. Rotate wheel and verify a minimum of 0.25 VAC sensor output at ~ 0.5 RPS. Verify condition of sensor head. Verify mounting of exciter ring and condition of teeth. Verify proper bearing endplay. Verify condition and retention of clamping sleeve. Verify sensor lead routing and clamping.
2	Output Low at Drive-off	Adjust sensor to contact exciter ring. Rotate wheel and verify a minimum of 0.25 VAC sensor output at ~ 0.5 RPS. Verify condition of sensor head. Verify mounting of exciter ring and condition of teeth. Verify proper bearing end-play. Verify condition and retention of clamping sleeve. Verify sensor lead routing and clamping.
3	Open or Shorted	Verify 1500 – 2500 ohms across sensor leads. Verify no continuity between sensor leads and ground or voltage. Verify no continuity between sensor leads and other sensors. Check for corroded/damaged wiring or connectors between the ECU and the wheel speed sensor.
4	Loss of Sensor Signal	Adjust sensor to contact exciter ring. Rotate wheel and verify a minimum of 0.25 VAC sensor output at ~ 0.5 RPS. Verify condition of sensor head. Verify mounting of exciter ring and condition of teeth. Verify proper bearing end-play. Verify condition and retention of clamping sleeve. Verify sensor lead routing and clamping. Check for corroded/damaged wiring or connectors between the ECU and the wheel speed sensor.
5	Wheel End	Verify mounting of exciter ring and condition of teeth. Verify proper bearing end-play. Verify condition and retention of clamping sleeve. Verify sensor lead routing and clamping. Check mechanical function of brake. Check for kinked or restricted air lines.
6	Erratic Sensor Signal	Adjust sensor to contact exciter ring. Rotate wheel and verify a minimum of 0.25 VAC sensor output at ~ 0.5 RPS. Verify condition of sensor head. Verify mounting of exciter ring and condition of teeth. Verify proper bearing end-play. Verify condition and retention of clamping sleeve. Verify sensor lead routing and clamping. Check for corroded/damaged wiring or connectors between the ECU and the wheel speed sensor.
7	Tire Size Calibration	Verify correct tire size as desired. Verify proper tire inflation. Verify correct number of exciter ring teeth.
8	Configuration Error	ECU is configured for four sensors, but has detected the presence of additional sensors. Verify sensor wiring and ECU configuration.

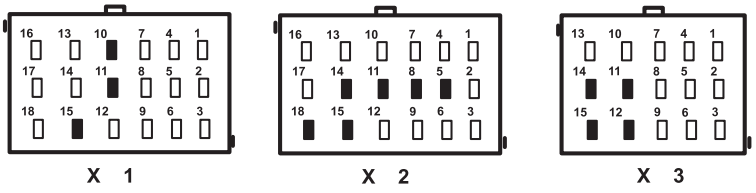
Speed Sensor Repair Tests:

1. Take all measurements at ECU harness connector pins in order to check wire harness and sensor. Probe the connector carefully so that the terminals are not damaged.
2. Wheel speed sensor measurements should read:

Location	Measurement
Sensor	1500 - 2500 Ohms
Sensor to voltage or ground	Open Circuit (no continuity)
Sensor output voltage	>0.25 of VAC sensor output at ~ 0.5 revs/sec.

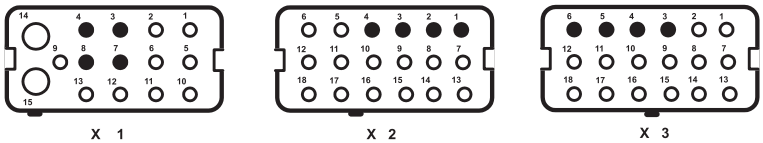
3. Clear DTC after issue is corrected. The sensor DTC will remain until the power is cycled to the ABS ECU and vehicle is driven above 15 MPH or DTC was cleared using either the diagnostic blink code switch or diagnostic tool.

Cab-mount ECU: Looking into wire harness connector



Connector	Pin	Wheel Speed Sensor Location
X1	10	Right Drive Axle (+)
18 Way	11	Right Drive Axle (-)
	5	Left Steer Axle (+)
X2	8	Left Steer Axle (-)
18 Way	11	Right Steer Axle (+)
	14	Right Steer Axle (-)
	15	Left Drive Axle (+)
	18	Left Drive Axle (-)
X3	11	Left Additional Axle (+)
15 Way (if Premium	14	Left Additional Axle (-)
ECU is configured	12	Right Additional Axle (+)
for 6 sensors)	15	Right Additional Axle (-)

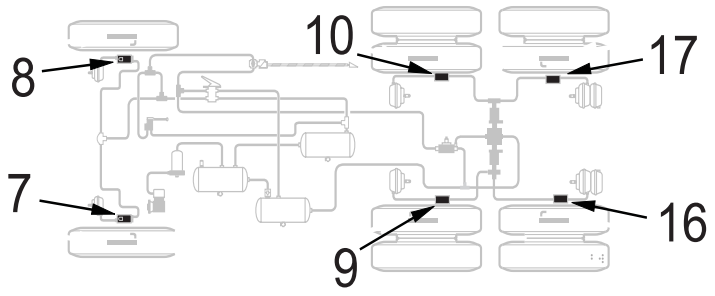
Frame-mount ECU: Looking into wire harness connector



Connector	Pin	Wheel Speed Sensor Location
	3	Left Steer Axle (+)
X1	7	Left Steer Axle (-)
15 Way	4	Right Steer Axle (+)
	8	Right Steer Axle (-)
	1	Left Drive Axle (+)
X2	2	Left Drive Axle (-)
18 Way	3	Right Drive Axle (+)
	4	Right Drive Axle (-)
X3	3	Left Additional Axle (+)
18 Way (if Premium	4	Left Additional Axle (-)
ECU is configured	5	Right Additional Axle (+)
for 6 sensors)	6	Right Additional Axle (-)

Troubleshooting Diagnostic Trouble Codes: Pressure Modulator Valves

1st. Blink Code	Location
7	Left Steer Axle
8	Right Steer Axle
9	Left Drive Axle
10	Right Drive Axle
16	Left Additional Axle
17	Right Additional Axle



2nd. Blink Code	Diagnostic Trouble Code Description	Repair Information
1	Release Solenoid Shorted to Ground	Verify no continuity between PMV leads and ground. Verify 4.9 to 5.5 ohms from REL to CMN & HLD to CMN, and 9.8 to 11 ohms from REL to HLD. Check for corroded/damaged wiring or connectors between ECU and PMV.
2	Release Solenoid Shorted to Voltage	Verify no continuity between PMV leads and voltage. Verify 4.9 to 5.5 ohms from REL to CMN & HLD to CMN, and 9.8 to 11 ohms from REL to HLD. Check for corroded/damaged wiring or connectors between ECU and PMV.
3	Release Solenoid Open Circuit	Verify 4.9 to 5.5 ohms from REL to CMN & HLD to CMN, and 9.8 to 11 ohms from REL to HLD. Check for corroded/damaged wiring or connectors between ECU and PMV.
4	Hold Solenoid Shorted to Ground	Verify no continuity between PMV leads and ground. Verify 4.9 to 5.5 ohms from REL to CMN & HLD to CMN, and 9.8 to 11 ohms from REL to HLD. Check for corroded/damaged wiring or connectors between ECU and PMV.
5	Hold Solenoid Shorted to Voltage	Verify no continuity between PMV leads and voltage. Verify 4.9 to 5.5 ohms from REL to CMN & HLD CMN, and 9.8 to 11 ohms from REL to HLD. Check for corroded/damaged wiring or connectors between ECU and PMV.
6	Hold Solenoid Open Circuit	Verify 4.9 to 5.5 ohms from REL to CMN & HLD to CMN, and 9.8 to 11 ohms from REL to HLD. Check for corroded/damaged wiring or connectors between the ECU and PMV.
7	CMN Open Circuit	Verify 4.9 to 5.5 ohms from REL to CMN & HLD to CMN, and 9.8 to 11 ohms from REL to HLD. Check for corroded/damaged wiring or connectors between the ECU and PMV.
8	Configuration Error	A mis-match exists between the ECU configuration and the modulator installation and wiring. Verify PMV wiring and installation. Verify ECU configuration.

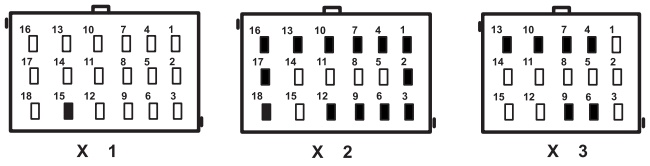
Pressure Modulator Valve Repair Tests:

1. Take all measurements at ECU harness connector pins in order to check wire harness and PMV. Probe the connector carefully so that the terminals are not damaged.
2. Pressure modulator resistance should read:

Location	Measurement
Release to Common	4.9 to 5.5 Ohms
Hold to Common	4.9 to 5.5 Ohms
Release to Hold	9.8 to 11.0 Ohms
Release, Hold, Common to Voltage or Ground	Open Circuit (no continuity)

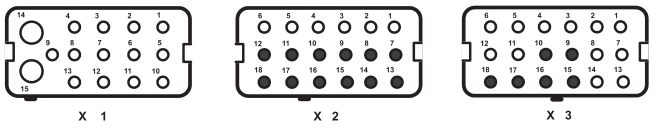
Caution: When troubleshooting modulator trouble codes, check inactive trouble codes and event history for over-voltage or excessive noise trouble codes. If one of these is found, troubleshoot these trouble codes first before the PMV.

Cab-mount ECU: Looking into wire harness connector



Connector	Pin	PMV Location
X2 18 Way	1	Left Steer Axle Hold
	2	Left Steer Axle Release
	3	Left Steer Axle Common
	4	Right Steer Axle Hold
	6	Right Steer Axle Common
	7	Right Steer Axle Release
	9	Right Drive Axle Common
	10	Right Drive Axle Hold
	13	Right Drive Axle Release
	12	Left Drive Axle Common
	16	Left Drive Axle Hold
	17	Left Drive Axle Release
X3 15 Way (if Premium ECU is configured for 6 sensors)	4	Left Additional Axle Hold
	6	Left Additional Axle Common
	7	Left Additional Axle Release
	9	Right Additional Axle Common
	10	Right Additional Axle Hold
	13	Right Additional Axle Release

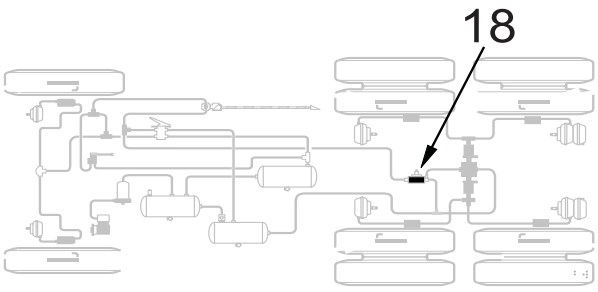
Frame-mount ECU: Looking into wire harness connector



Connector	Pin	PMV Location
X2 18 Way	7	Left Steer Axle Hold
	8	Left Steer Axle Release
	13	Left Steer Axle Common
	9	Right Steer Axle Hold
	10	Right Steer Axle Release
	14	Right Steer Axle Common
	11	Left Drive Axle Hold
	12	Left Drive Axle Release
	15	Left Drive Axle Common
	16	Right Drive Axle Common
	17	Right Drive Axle Hold
	18	Right Drive Axle Release
X3 15 Way (if Premium ECU is configured for 6 sensors)	9	Left Additional Axle Hold
	10	Left Additional Axle Release
	15	Left Additional Axle Common
	16	Right Additional Axle Common
	17	Right Additional Axle Hold
	18	Right Additional Axle Release

Troubleshooting Diagnostic Trouble Codes: Traction Control Valves

1st. Blink Code	Location
18	Traction Control Valve



2nd. Blink Code	Diagnostic Trouble Code Description	Repair Information
1	TCV Solenoid Shorted to Ground	Verify 7 to 19 ohms between TCV and TCV common. Verify no continuity between TCV leads and ground. Check for corroded/damaged wiring or connectors between ECU and TCV.
2	TCV Solenoid Shorted to Voltage	Verify 7 to 19 ohms between TCV and TCV common. Verify no continuity between TCV leads and voltage. Check for corroded/damaged wiring or connectors between ECU and TCV.
3	TCV Solenoid Open Circuit	Verify 7 to 19 ohms between TCV and TCV common. Check for corroded/ damaged wiring or connectors between ECU and TCV.
4	TCV Configuration Error	The ECU is not configured for ATC, but has detected the presence of a TCV. Verify TCV wiring. Inspect for the presence of a TCV. Verify ECU configuration.

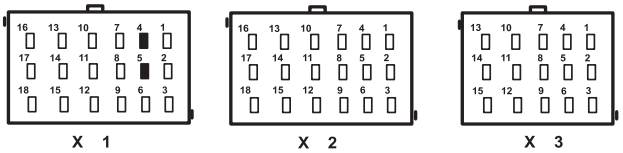
Traction Control Valve Repair Tests:

1. Take all measurements at ECU harness connector pins in order to check wire harness and traction control valve. Probe the connector carefully so that the terminals are not damaged.
2. Tractor Control Valve resistance measurements should read:

Location	Measurement
TCV to TCV Common	7 to 19 Ohms
Release, Hold, Common to Voltage or Ground	Open Circuit (no continuity)

Cab-mount ECU:

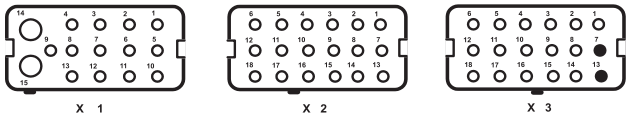
Looking into wire harness connector



Connector	Pin	Traction Control Test
X1	4	Traction Control Valve Common
18 Way	5	Traction Control Valve

Frame-mount ECU:

Looking into wire harness connector



Connector	Pin	Traction Control Test
X3	7	Traction Control Valve
18 Way	13	Traction Control Valve Common

Troubleshooting Diagnostic Trouble Codes: Power Supply

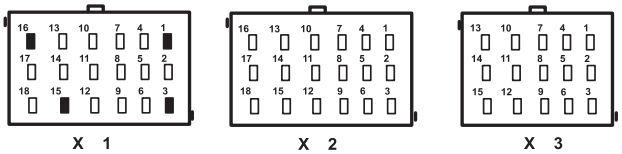
1st. Blink Code	Location
6	Power Supply

2nd. Blink Code	Diagnostic Trouble Code Description	Repair Information
1	Battery Voltage Too Low	Measure battery voltage under load. Check vehicle battery and associated components. Check for damaged wiring. Check for damaged or corroded connectors and connections.
2	Battery Voltage Too High	Measure battery voltage under load. Insure that battery voltage is correct for the model of ECU. Check vehicle battery and associated components. Check for damaged wiring. Check for damaged or corroded connectors and connections.
3	Battery Voltage Too Low During ABS	Measure battery voltage under load. Check vehicle battery and associated components. Check for damaged wiring. Check for damaged or corroded connectors and connections.
4	Battery Voltage Open Circuit	Measure battery voltage under load. Check condition of fuse. Check vehicle battery and associated components. Check for damaged wiring. Check for damaged or corroded connectors and connections.
5	Ignition Voltage Too Low	Measure ignition voltage under load. Check vehicle battery and associated components. Check for damaged wiring. Check for damaged or corroded connectors and connections. Check condition of fuse.
6	Ignition Voltage Too High	Measure ignition voltage. Insure that ignition voltage is correct for the model of ECU. Check vehicle battery and associated components. Check for damaged wiring. Check for damaged or corroded connectors and connections.
7	Ignition Voltage Too Low During ABS	Measure ignition voltage under load. Check vehicle battery and associated components. Check for damaged wiring. Check for damaged or corroded connectors and connections.
8	Input Voltage Has Excessive Noise (Temporary)	Check alternator output for excessive noise. Check for other devices causing excessive noise.
9	Input Voltage Has Excessive Noise	Check alternator output for excessive noise. Check for other devices causing excessive noise.

Power Supply Tests:

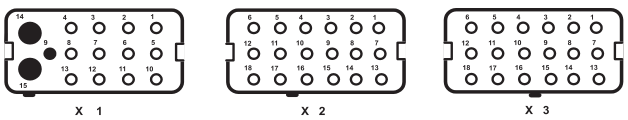
1. Take all measurements at ECU harness connector.
2. Place a load (e.g. an 1157 stop lamp) across battery or ignition and ground connection, measure ignition and battery voltage with the load. Ignition to Ground should measure between 9 to 17 VDC. Battery to Ground should also measure between 9 to 17 VDC.
3. Check for damaged wiring, damaged or corroded connectors and connections.
4. Check condition of vehicle battery and associated components, ground connection good and tight.
5. Check alternator output for excessive noise.

Cab-mount ECU:
Looking into wire harness connector



Connector	Pin	Power Supply Test
X1	1	Ground
18 Way	3	Ignition
	16	Battery

Frame-mount ECU:
Looking into wire harness connector



Connector	Pin	Power Supply Test
X1	9	Ignition
15 Way	14	Battery
	15	Ground

Troubleshooting Diagnostic Trouble Codes: J1939 Serial Communications

1st. Blink Code	Location
11	J1939

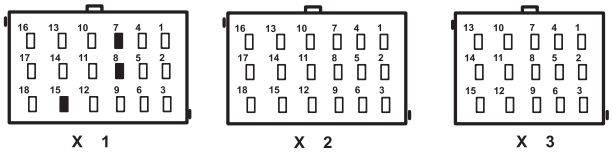
2nd. Blink Code	Diagnostic Trouble Code Description	Repair Information
1	J1939 Serial Link	Loss of communications between the EC-60™ controller and other devices connected to the J1939 link. Check for damaged or reversed J1939 wiring. Check for corroded or damaged connectors. Verify ECU Configuration. Check for other devices inhibiting J1939 communications.
2	J1939 Retarder	Loss of communications between the EC-60™ controller and other devices connected to the J1939 link. Check for damaged or reversed J1939 wiring. Check for corroded or damaged connectors. Verify presence of retarder on the J1939 link. Verify ECU Configuration. Check for other devices inhibiting J1939 communications.
3	J1939 Engine Communications	Loss of communications between the EC-60™ controller and the engine ECU over the J1939 link. Check for damaged or reversed J1939 wiring. Check for corroded or damaged connectors. Verify presence of engine ECU on the J1939 link. Verify ECU Configuration. Check for other devices inhibiting J1939 communications.

J1939 Troubleshooting Tests:

1. Take all measurements at ECU harness connector
2. Check for damaged or reversed J1939 wiring
3. Check for corroded or damaged wiring connector problems such as (opens or shorts to voltage or ground)
4. Check for other J1939 devices which may be loading down (inhibiting) J1939 communication

Cab-mount ECU:

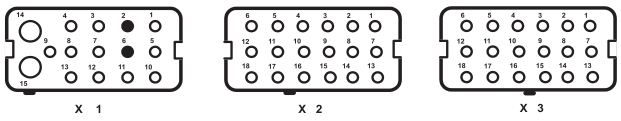
Looking into wire harness connector



Connector	Pin	J1939
X1	7	J1939 Low
18 Way	8	J1939 High

Frame-mount ECU:

Looking into wire harness connector



Connector	Pin	J1939
X1	2	J1939 Low
18 Way	6	J1939 High

Troubleshooting Diagnostic Trouble Codes: ECU

1st. Blink Code	Location
13	ECU

2nd. Blink Code	Diagnostic Trouble Code Description	Repair Information
2	ECU (10)	ALL: Check for damaged or corroded connectors. Check for damaged wiring. Clear trouble codes. If diagnostic trouble codes return, replace the ECU.
3	ECU (11)	
4	ECU (12)	
5	ECU (13)	
6	ECU (14)	
7	ECU (15)	
8	ECU (16)	
9	ECU (17)	
10	ECU (18)	
11	ECU (1A)	
12	ECU (1B)	
13	ECU (80)	

Troubleshooting Diagnostic Trouble Codes: Miscellaneous

1st. Blink Code	Location
12	Miscellaneous

2nd. Blink Code	Diagnostic Trouble Code Description	Repair Information
1	Stop Lamp Switch Not Detected	ECU has not detected the presence of the stop lamp switch since ignition power was applied (note that stop lamp switch input may be applied to the EC-60™ controller using either hardwire input or J1939). Apply and release service brake. Check for brake switch input into ECU (see system wiring schematic). With service brake released, check for presence of the stop lamp bulb. With service brake applied, verify system voltage is now present at the stop lamp switch input to the ECU. Check for damaged wiring between ECU, stop lamp switch and bulb. Check for corroded or damaged connectors. Check for damaged or reversed J1939 wiring. Check for corroded or damaged connectors on J1939 link. Verify presence of engine ECU on the J1939 link. Verify ECU configuration.
2	Stop Lamp Switch Defective	Apply and release service brake. Check for brake switch input into ECU (see system wiring schematic). With service brake released, check for presence of the stop lamp bulb. With service brake applied, verify system voltage is now present at the stop lamp switch input to the ECU. Check for damaged wiring between ECU, stop lamp switch and bulb. Check for corroded or damaged connectors. Check for damaged or reversed J1939 wiring. Check for corroded or damaged connectors on J1939 link. Verify presence of engine ECU on the J1939 link. Verify ECU configuration.
3	Dynamometer Test Mode	ECU has been placed in the Dynamometer Test Mode by either the diagnostic blink code switch or a hand-held or PC-based diagnostic tool. ATC is disabled.
4	Retarder Relay Open Circuit or Shorted to Ground	Verify vehicle contains a retarder relay. Verify ECU configuration. Check wiring between ECU and retarder relay. Verify no continuity between retarder disable output of EC-60™ controller and ground. Verify condition and wiring of the retarder relay.
5	Retarder Relay Circuit Shorted to Voltage	Check wiring between ECU and retarder relay. Verify no continuity between retarder disable output of EC-60™ controller and voltage. Verify condition and wiring of the retarder relay.
6	ABS Indicator Lamp Circuit Fault	Check operation of diagnostic blink code switch. Check wiring of diagnostic blink code switch, ABS WL, and ABS WL relay (frame ECUs only). Verify ABS WL ground input (cab ECUs only).
7	PMV Common Shorted to Ground	Verify no continuity between the CMN of all PMVs, TCV, and Diff Lock Solenoid and ground. Check for corroded/damaged wiring or connectors between the ECU and CMN of all PMVs, TCV, and Diff Lock Solenoid.
8	PMV Common Shorted to Voltage	Verify no continuity between the CMN of all PMVs, TCV, and Diff Lock Solenoid and voltage. Check for corroded/damaged wiring or connectors between the ECU and CMN of all PMVs, TCV, and Diff Lock Solenoid.
9	ATC Disabled to Prevent Brake Fade	ATC is temporarily disabled to prevent excessive heating of the foundation brakes.
10	Tire Size Out of Range (Front to Rear)	Verify correct tire size as desired. Verify proper tire inflation. Verify correct number of exciter ring teeth. Verify that the ECU has the proper tire size settings.
11	Wheel Speed Sensors Reversed on an Axle	Sensors are reversed (left to right) on one of the axles. Verify proper installation, connection, and wiring of the sensors.
12	Diff. Lock Solenoid Shorted to Ground or Open Circuit	Verify no continuity between the Diff Lock Solenoid and ground. Check for corroded/damaged wiring or connectors between the ECU and Diff Lock Solenoid.
13	Diff. Lock Solenoid Shorted to Voltage	Verify no continuity between the Diff Lock Solenoid and voltage. Check for corroded/damaged wiring or connectors between the ECU and Diff Lock Solenoid.

Miscellaneous Troubleshooting

For all tests below, take all measurements at ECU harness connector pins in order to check wire harness and sensor. Probe the connector carefully so that the terminals are not damaged.

Stop Lamp Switch Test

1. With the service brake applied, measure the system voltage (9 to 17 VDC) stop lamp switch input to ECU.

Test	Measurement
Stop Lamp Switch to Ground	9 to 17 VDC

2. Apply and release service brake, does lamp extinguish?
3. Verify brake lamp switch is connected to ECU via hard wire or J1939.
4. With service brake released, check for presence of stop lamp bulb.

Dynamometer Test Mode (ATC Indicator Lamp Continuously Illuminated)

1. Clear the dynamometer test mode by depressing and releasing the blink code switch three times (or use an off-board diagnostic tool).

ABS Indicator Lamp

1. Verify diagnostic blink code switch is open when not activated.

Retarder Relay

1. Measure resistance between retarder disable output of EC-60™ controller and voltage / ground.

Test	Measurement
Retarder disable to Voltage or Ground	Open Circuit (no continuity)

2. Verify vehicle has retarder relay.
3. Verify proper wiring from ECU to retarder relay.

PMV Commons

1. Measure resistance between any common (PMV, TCV, and Diff.) and voltage or ground.

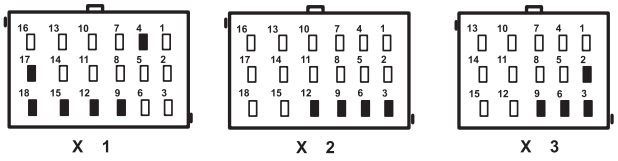
Test	Measurement
Any PMV, TCV, or Diff. Common to Voltage or Ground	Open Circuit (no continuity)

Differential Lock Solenoid

1. Measure resistance between Diff lock solenoid and voltage or ground.

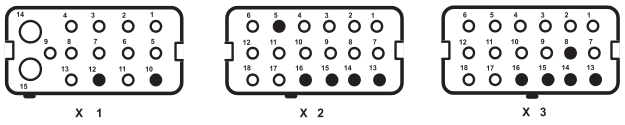
Test	Measurement
Diff. Lock Solenoid to Voltage or Ground	Open Circuit (no continuity)

Cab-mount ECU: Looking into wire harness connector



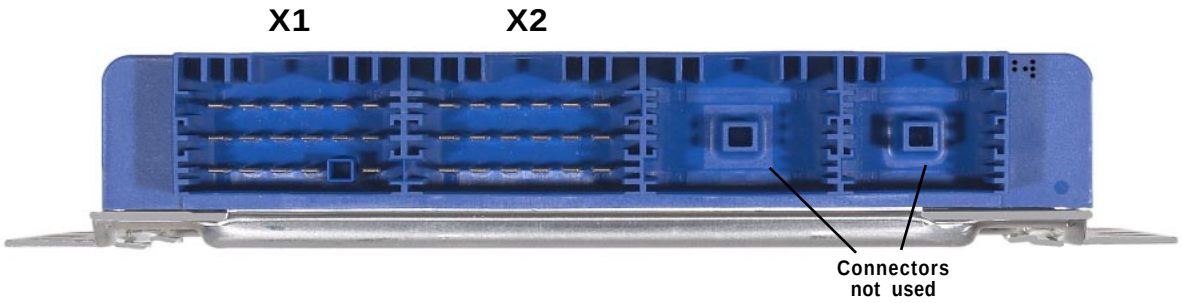
Connector	Pin	PMV Location
X1 18 Way	4	TCV Common
	9	Stop Lamp Switch
	12	ABS WL Ground
	15	ABS WL Interlock
	17	Retarder
	18	ABS WL
X2 18 Way	3	PMV Left Steer Axle Common
	6	PMV Right Steer Axle Common
	9	PMV Right Drive Axle Common
	12	PMV Left Drive Axle Common
X3 15 Way	2	Diff Lock Solenoid
	3	Diff Lock Solenoid Common
	6	PMV Left Additional Axle Common
	9	PMV Right Additional Axle Common

Frame-mount ECU: Looking into wire harness connector



Connector	Pin	PMV Location
X1 18 Way	10	Retarder
	12	ABS WL
X2 18 Way	5	Stop Lamp Switch
	13	PMV Left Steer Axle Common
	14	PMV Right Steer Axle Common
	15	PMV Left Drive Axle Common
	16	PMV Right Drive Axle Common
X3 15 Way	8	Diff. Lock Solenoid
	13	TCV Common
	14	Diff. Lock Solenoid Common
	15	PMV Left Additional Axle Common
	16	PMV Right Additional Axle Common

EC-60™ Controller Wire Harness Connector Part Numbers and Pin Assignments: STANDARD CAB



Standard Cab EC-60™ Controller

Standard cab models utilize two AMP connectors for wire harness connections.

Connector Designation	Number of Contacts	AMP Part Number
X1	17	1718091-1
X2	18	8-968974-1

Standard Cab X1 Connector Pin Assignments

Pin	Designation	Pin	Designation	Pin	Designation
1	Ground	7	J1939 Low	13	J1587 (B)
2	Trailer ABS WL	8	J1939 High	14	J1587 (A)
3	Ignition	**9**	**Not Used**	15	ABS WL Interlock
4	**Not Used**	10	WSS DA Right (+)	16	Battery
5	**Not Used**	11	WSS DA Right (-)	17	Retarder
6	**Not Used**	12	ABS WL Ground	18	ABS WL

Standard Cab X2 Connector Pin Assignments

Pin	Designation	Pin	Designation	Pin	Designation
1	PMV SA Left HLD	7	PMV SA Right REL	13	PMV DA Right REL
2	PMV SA Left REL	8	WSS SA Left (-)	14	WSS SA Right (-)
3	PMV SA Left CMN	9	PMV DA Right CMN	15	WSS DA Left (+)
4	PMV SA Right HLD	10	PMV DA Right HLD	16	PMV DA Left HLD
5	WSS SA Left (+)	11	WSS SA Right (+)	17	PMV DA Left REL
6	PMV SA Right CMN	12	PMV DA Left CMN	18	WSS DA Left (-)

EC-60™ Controller Wire Harness Connector Part Numbers and Pin Assignments:
STANDARD FRAME

Standard Frame EC-60™ Controller

Standard frame models utilize two Deutsch connectors for wire harness connections.

Connector Designation	Number of Contacts	Deutsch Part Number
X1	15	DT16-15SA-K003
X2	18	DT16-18SB-K004

Standard Frame X1 Connector Pin Assignments

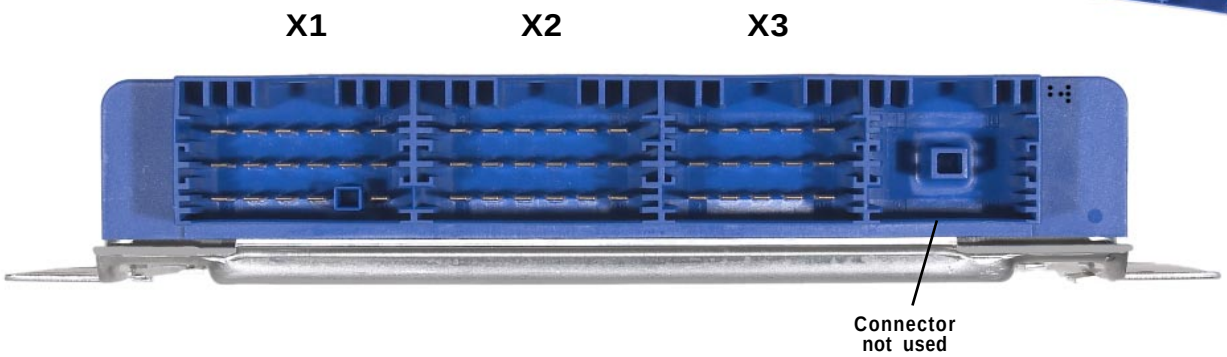
Pin	Designation	Pin	Designation	Pin	Designation
1	J1587 (B)	6	J1939 High	11	Trailer ABS WL
2	J1939 Low	7	WSS SA Left (-)	12	ABS WL
3	WSS SA Left (+)	8	WSS SA Right (-)	**13**	**Not Used**
4	WSS SA Right (+)	9	Ignition	14	Battery
5	J1587 (A)	10	Retarder	15	Ground

Standard Frame X2 Connector Pin Assignments

Pin	Designation	Pin	Designation	Pin	Designation
1	WSS DA Left (+)	7	PMV SA Left HLD	13	PMV SA Left CMN
2	WSS DA Left (-)	8	PMV SA Left REL	14	PMV SA Right CMN
3	WSS DA Right (+)	9	PMV SA Right HLD	15	PMV DA Left CMN
4	WSS DA Right (-)	10	PMV SA Right REL	16	PMV DA Right CMN
5	**Not Used**	11	PMV DA Left HLD	17	PMV DA Right HLD
6	**Not Used**	12	PMV DA Left REL	18	PMV DA Right REL

EC-60™ Controller Wire Harness Connector Part Numbers and Pin Assignments:

PREMIUM CAB



Premium Cab Model EC-60™ Controller

Premium cab models utilize three AMP connectors for wire harness connections.

Connector Designation	Number of Contacts	AMP Part Number
X1	17	1718091-1
X2	18	8-968974-1
X3	15	8-968973-1

Premium Cab X1 Connector Pin Assignments

Pin	Designation	Pin	Designation	Pin	Designation
1	Ground	7	J1939 Low	13	J1587 (B)
2	Trailer ABS WL	8	J1939 High	14	J1587 (A)
3	Ignition	9	SLS	15	ABS WL Interlock
4	TCV CMN	10	WSS DA Right (+)	16	Battery
5	TCV	11	WSS DA Right (-)	17	Retarder
6	ATC Lamp/ATC ORS	12	ABS WL Ground	18	ABS WL

Premium Cab X2 Connector Pin Assignments

Pin	Designation	Pin	Designation	Pin	Designation
1	PMV SA Left HLD	7	PMV SA Right REL	13	PMV DA Right REL
2	PMV SA Left REL	8	WSS SA Left (-)	14	WSS SA Right (-)
3	PMV SA Left CMN	9	PMV DA Right CMN	15	WSS DA Left (+)
4	PMV SA Right HLD	10	PMV DA Right HLD	16	PMV DA Left HLD
5	WSS SA Left (+)	11	WSS SA Right (+)	17	PMV DA Left REL
6	PMV SA Right CMN	12	PMV DA Left CMN	18	WSS DA Left (-)

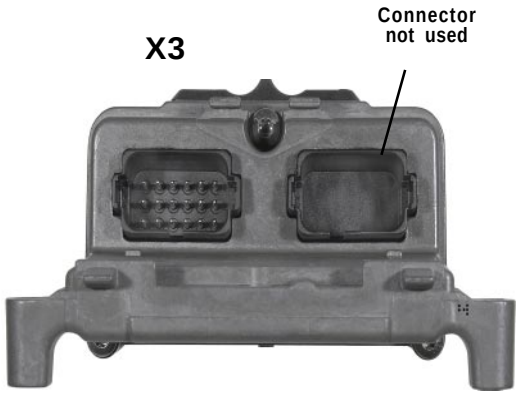
Premium Cab X3 Connector Pin Assignments

Pin	Designation	Pin	Designation	Pin	Designation
1	ABS ORS	6	PMV AA Left CMN	11	WSS AA Left (+)
2	Diff. Lock SOL[1]	7	PMV AA Left REL	12	WSS AA Right (+)
3	Diff. Lock SOL CMN[1]	8	Reserved	13	PMV AA Right REL
4	PMV AA Left HLD	9	PMV AA Right CMN	14	WSS AA Left (-)
5	Reserved	10	PMV AA Right HLD	15	WSS AA Right (-)

[1]AWD vehicles only. (AWD Transfer Case)

EC-60™ Controller Wire Harness Connector Part Numbers and Pin Assignments:

PREMIUM FRAME



Premium Frame Model EC-60™ Controller

Premium frame models utilize three Deutsch enactors for wire harness connections.

Connector Designation	Number of Contacts	Deutsch Part Number
X1	15	DT16-15SA-K003
X2	18	DT16-18SB-K004
X3	18	DT16-18SC-K004

Premium Frame X1 Connector Pin Assignments

Pin	Designation	Pin	Designation	Pin	Designation
1	J1587 (B)	6	J1939 High	11	Trailer ABS WL
2	J1939 Low	7	WSS SA Left (-)	12	ABS WL
3	WSS SA Left (+)	8	WSS SA Right (-)	13	ATC Lamp/ATC ORS
4	WSS SA Right (+)	9	Ignition	14	Battery
5	J1587 (A)	10	Retarder	15	Ground

Premium Frame X2 Connector Pin Assignments

Pin	Designation	Pin	Designation	Pin	Designation
1	WSS DA Left (+)	7	PMV SA Left HLD	13	PMV SA Left CMN
2	WSS DA Left (-)	8	PMV SA Left REL	14	PMV SA Right CMN
3	WSS DA Right (+)	9	PMV SA Right HLD	15	PMV DA Left CMN
4	WSS DA Right (-)	10	PMV SA Right REL	16	PMV DA Right CMN
5	SLS	11	PMV DA Left HLD	17	PMV DA Right HLD
6	ABS ORS	12	PMV DA Left REL	18	PMV DA Right REL

Premium Frame X3 Connector Pin Assignments

Pin	Designation	Pin	Designation	Pin	Designation
1	Reserved	7	TCV	13	TCV CMN
2	Not Used	8	Diff. Lock SOL[1]	14	Diff. Lock SOL CMN[1]
3	WSS AA Left (+)	9	PMV AA Left HLD	15	PMV AA Left CMN
4	WSS AA Left (-)	10	PMV AA Left REL	16	PMV AA Right CMN
5	WSS AA Right (+)	11	Reserved	17	PMV AA Right HLD
6	WSS AA Right (-)	12	Reserved	18	PMV AA Right REL

[1]AWD vehicles only. (AWD Transfer Case)

Troubleshooting: Wiring

ABS/ATC WIRING

CAB ECU Wiring Harness Connectors

The in-cab EC-60™ controllers are designed to interface with AMP MCP 2.8 connectors as referenced in Chart 4. Follow all AMP requirements for the repair of wire harnesses.

All wire harness connectors must be properly seated. The use of secondary locks is strongly advised.

CAUTION: All unused ECU connectors must be covered and receive proper environmental protection.

Frame ECU Wiring Harness Connectors

Frame-mount EC-60™ controllers are designed to interface with Deutsch connectors as referenced in Chart 4.

CAUTION: The frame wire harness connectors must be properly seated with the seals intact (undamaged). All unused connector terminals must be plugged with the appropriate sealing plugs. Failure to properly seat or seal the connectors could result in moisture or corrosion damage to the connector terminals. ECUs damaged by moisture and/or corrosion are not covered under the Bendix warranty. Secondary locks must be snapped securely in place.

Follow all Deutsch requirements for the repair of wire harnesses.

CAUTION: All unused connector terminals must be plugged with the appropriate sealing plugs.

Frame ECU Connector Covers

Frame ECUs are provided with covers that must be removed to permit connection of the vehicle wiring harness. The cover can be removed by sliding the slide lock mechanism to the unlock position.

The covers provide strain relief and connector protection of the vehicle wire harness and will accept round convoluted conduit with an I.D. of 19 mm.

ABS Wiring Requirements

As a matter of good practice and to insure maximum system robustness, always use the maximum size wire supported by the wire harness connectors for battery, ignition, ground, PMV, TCV, Interaxle Differential Lock and indicator lamp circuits.

All sensor and serial communications circuits (J1587 and J1939) must use twisted pair wiring (one to two twists per inch). See the appropriate SAE document for additional details.

WARNING: All wires must be carefully routed to avoid contact with rotating elements. Wiring must be properly secured approximately every 6 to 12 inches using UV stabilized, non-metallic hose clamps or bow-tie cable ties to prevent pinching, binding or fraying.

It is recommended that wires be routed straight out of a connector for a minimum of three inches before the wire is allowed to bend.

Battery and ground wires should be kept to a minimum length.

If convoluted tubing is used, its I.D. must match the size of the wire bundle as closely as possible.

CAUTION: Wire harness lengths must be carefully selected for the vehicle. Harnesses that are too long increase the possibility of electrical interference and wire damage. Excess lengths of wire are **not** to be wound to form coils, instead re-route, repair or replace wire harness. Do not attempt to stretch harnesses that are too short, since mechanical strain can result in wire breakage.

ABS Component	Connector	Wire Terminal	Wire Seal/ Plug	Terminal Lock	Terminal Crimp Tool
In-Cab Controller Harness 17-Way AMP MCP 2.8 (X1)	 1718091-1	 927768-9 1 - 2.5 mm² X1-12 & 18	N/A	 967634	 539723-2
In-Cab Controller Harness 18-Way AMP MCP 2.8 (X2)	 8-968974-1	 968874 2.5 - 4 mm²	N/A	N/A	
In-Cab Controller Harness 15-Way AMP MCP 2.8 (X3)	 8-968973-1	 968873 1.0 - 2.5 mm²	N/A	N/A	
Frame Controller Harness 15-Way Deutsch (X1)	 DT16-15SA-K003	 0462-203-12XX (Solid) (or alternatively use 1062-12-01) 12 AWG X1- 14 & 15	N/A	N/A	 HDT-48-00
Frame Controller Harness 18-Way Deutsch (X2)	 DT16-18SB-K004	 0462-201-16XX (Solid) (or alternatively use a stamped and formed version: 1062-16-06) 16-18 AWG	N/A	N/A	
Frame Controller Harness 18-Way Deutsch (X3)	 DT16-18SC-K004		N/A	N/A	
ABS Modulator Harness AMP Twist-Lock (Bayonet)	 1-967325-2	 929975-1	N/A	N/A	 539635-1
ATC Modulator Harness AMP Twist-Lock (Bayonet)	 1-967325-3	 929975-1	N/A	N/A	
ABS Modulator Harness 3-pin Packard Metri-Pack 280 Series	 12040977	 12077411	 12015323	 12034145	 12155975

WS-24™ Wheel Speed Sensor Connectors


Packard GT 150 series


Packard Metripack 150.2 series


Deutsch DTM06 series


Packard Metripack 280 series (female)


Packard Metripack 280 series (male)


Deutsch DT04 series


Standard round two pin

CHART 4 - EC-60™ CONTROLLER COMPONENT CONNECTORS

Troubleshooting: Wiring (Continued)

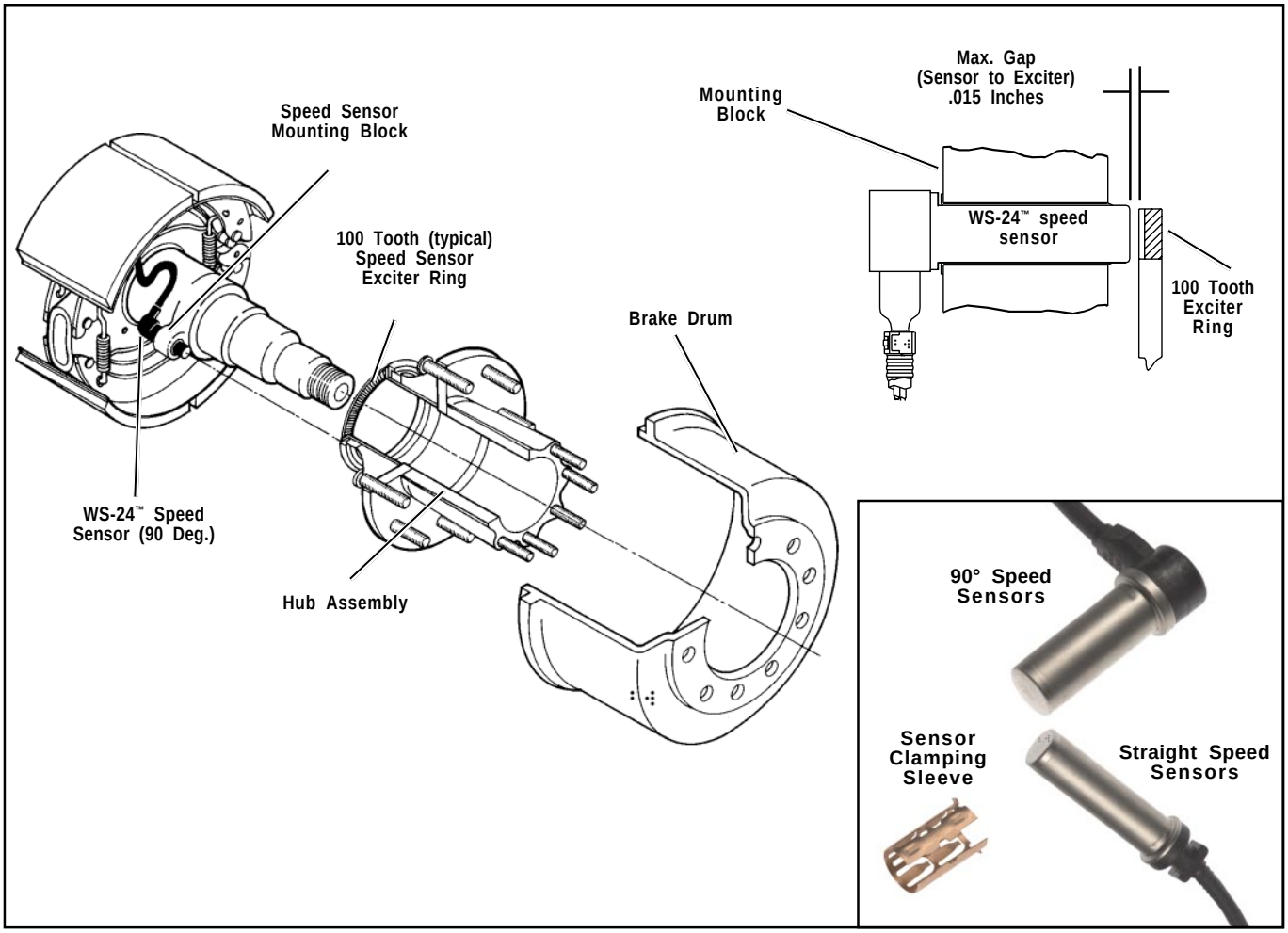


*FIGURE 15 - **WS-24™ WHEEL SPEED SENSOR INSTALLATION***

Wheel Speed Sensor Wiring

Route sensor wiring coming out of the wheel ends away from moving brake components. Sensor wiring needs to be secured to the axle to prevent excess cable length and wiring damage. It is required that cable ties be installed to the sensor wire within 3 inches (76.2 mm) of the sensor head to provide strain relief.

Following the axle, the sensor wires must be attached along the length of the service brake hoses using cable ties with ultraviolet protection and secured every 6 to 8 inches (152 to 203 mm). Sufficient – but not excessive – cable length must be provided to permit full suspension travel and steering axle movement. Install wires so that they cannot touch rotating elements such as wheels, brake discs or drive shafts. Radiation protection may be necessary in the area of brake discs.

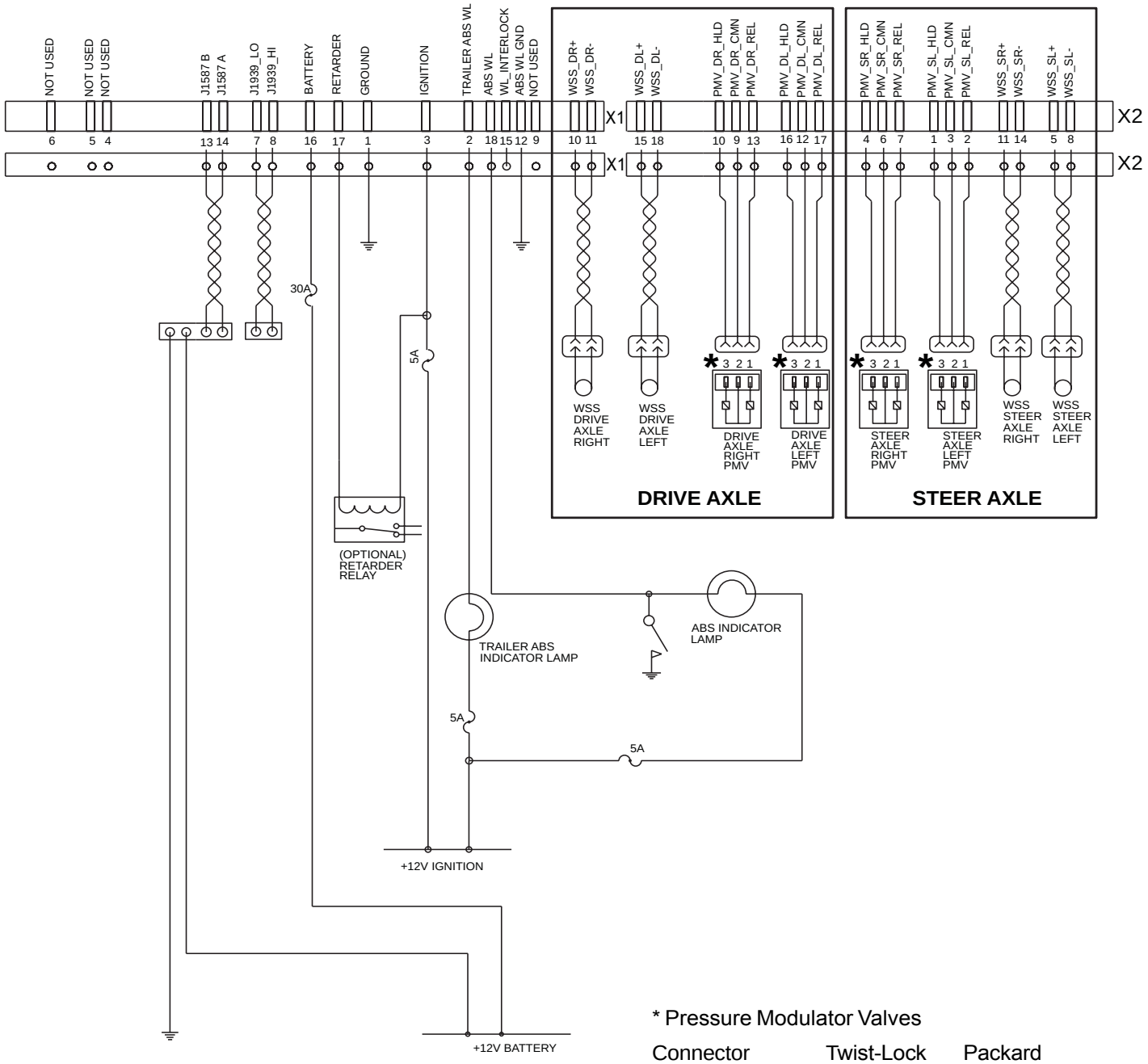
Bendix does not recommend using standard tie-wraps to secure wiring harnesses directly to rubber air lines. This may cause premature wiring failure from the pressure exerted on the wiring when air pressure is applied through the air line. Non-metallic hose clamps or bow-tie tie-wraps are preferred.

The use of grommets or other suitable protection is required whenever the cable must pass through metallic frame members.

All sensor wiring must utilize twisted pair wire, with approximately one to two twists per inch.

It is recommended that wires be routed straight out of a connector for a minimum of three inches before the wire is allowed to bend.

Troubleshooting: Standard Cab Wiring Schematic (4S/4M)



* Pressure Modulator Valves

Connector	Twist-Lock	Packard
Common (CMN)	Pin 2	Pin B
Hold (HLD)	Pin 3	Pin C
Release (REL)	Pin 1	Pin A

FIGURE 16 - STANDARD CAB WIRING SCHEMATIC (4S/4M)

Troubleshooting: Premium Cab Wiring Schematic (6S/6M)

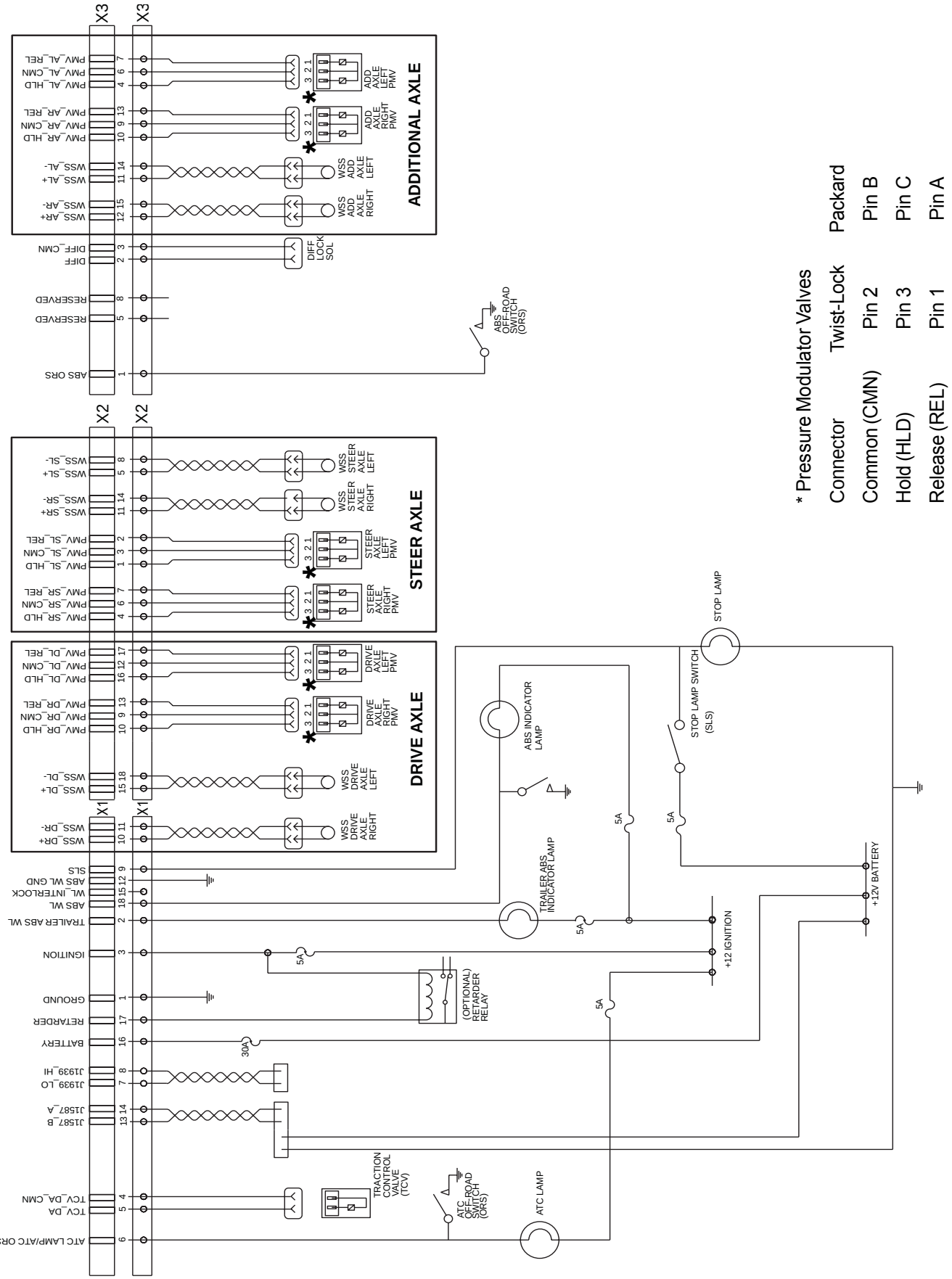


FIGURE 17 - PREMIUM CAB WIRING SCHEMATIC (6S/6M)

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Troubleshooting: Premium Cab Wiring Schematic (6S/5M)

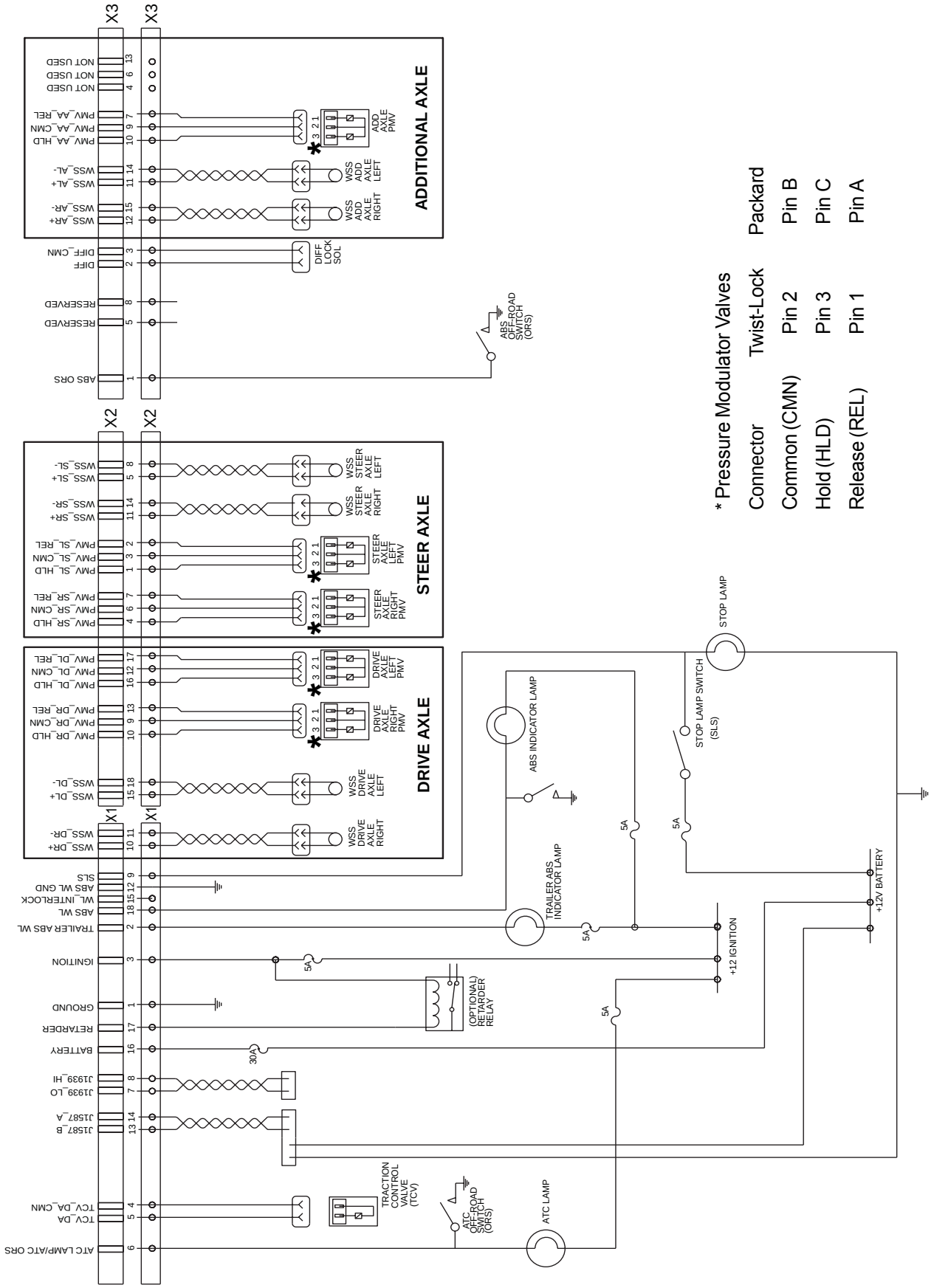
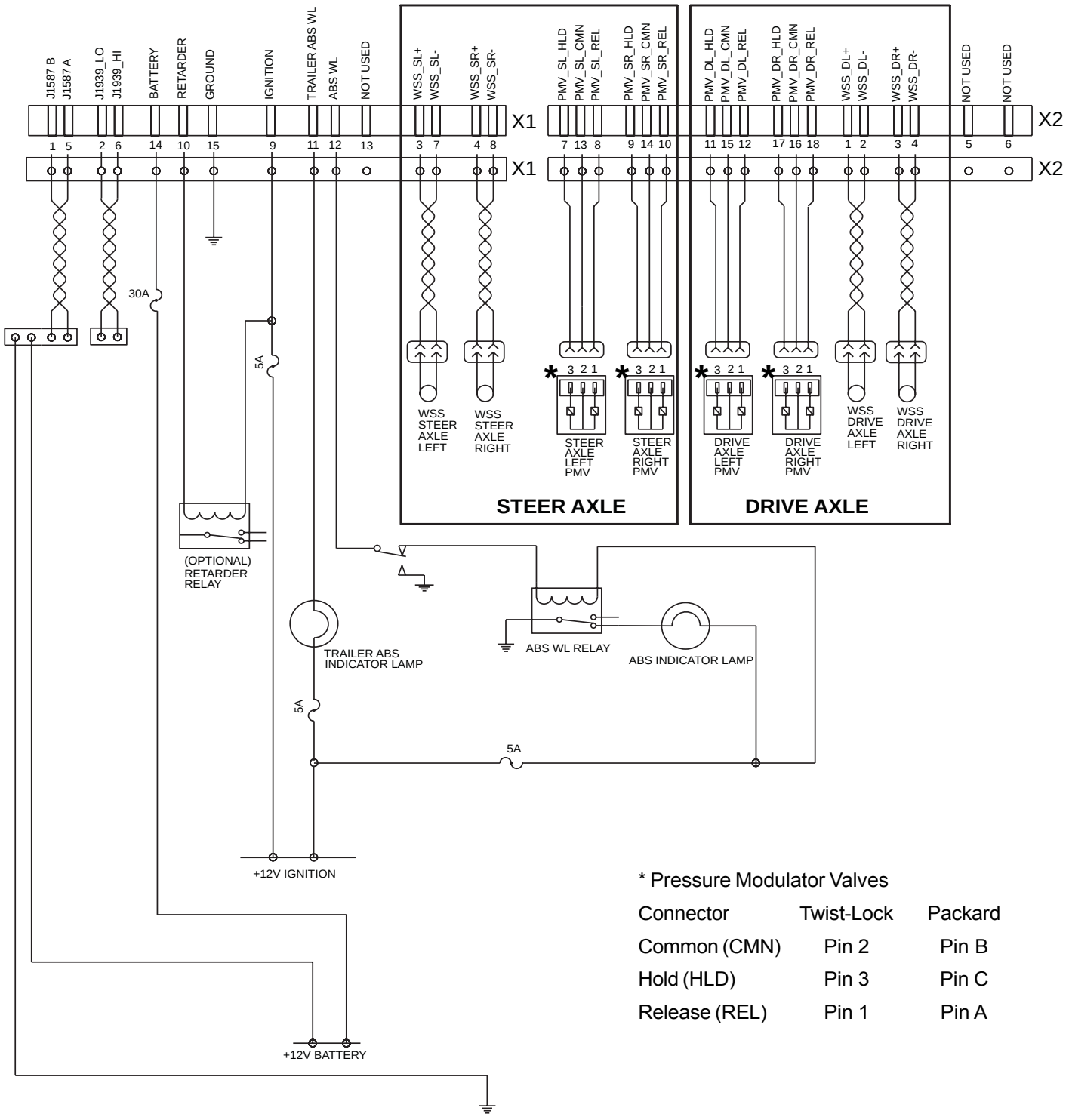


FIGURE 18 - PREMIUM CAB WIRING SCHEMATIC (6S/5M)

Troubleshooting: Standard Frame Wiring Schematic (4S/4M)



* Pressure Modulator Valves

Connector	Twist-Lock	Packard
Common (CMN)	Pin 2	Pin B
Hold (HLD)	Pin 3	Pin C
Release (REL)	Pin 1	Pin A

FIGURE 19 - STANDARD FRAME WIRING SCHEMATIC (4S/4M)

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Troubleshooting: Premium Frame Wiring Schematic (6S/6M)

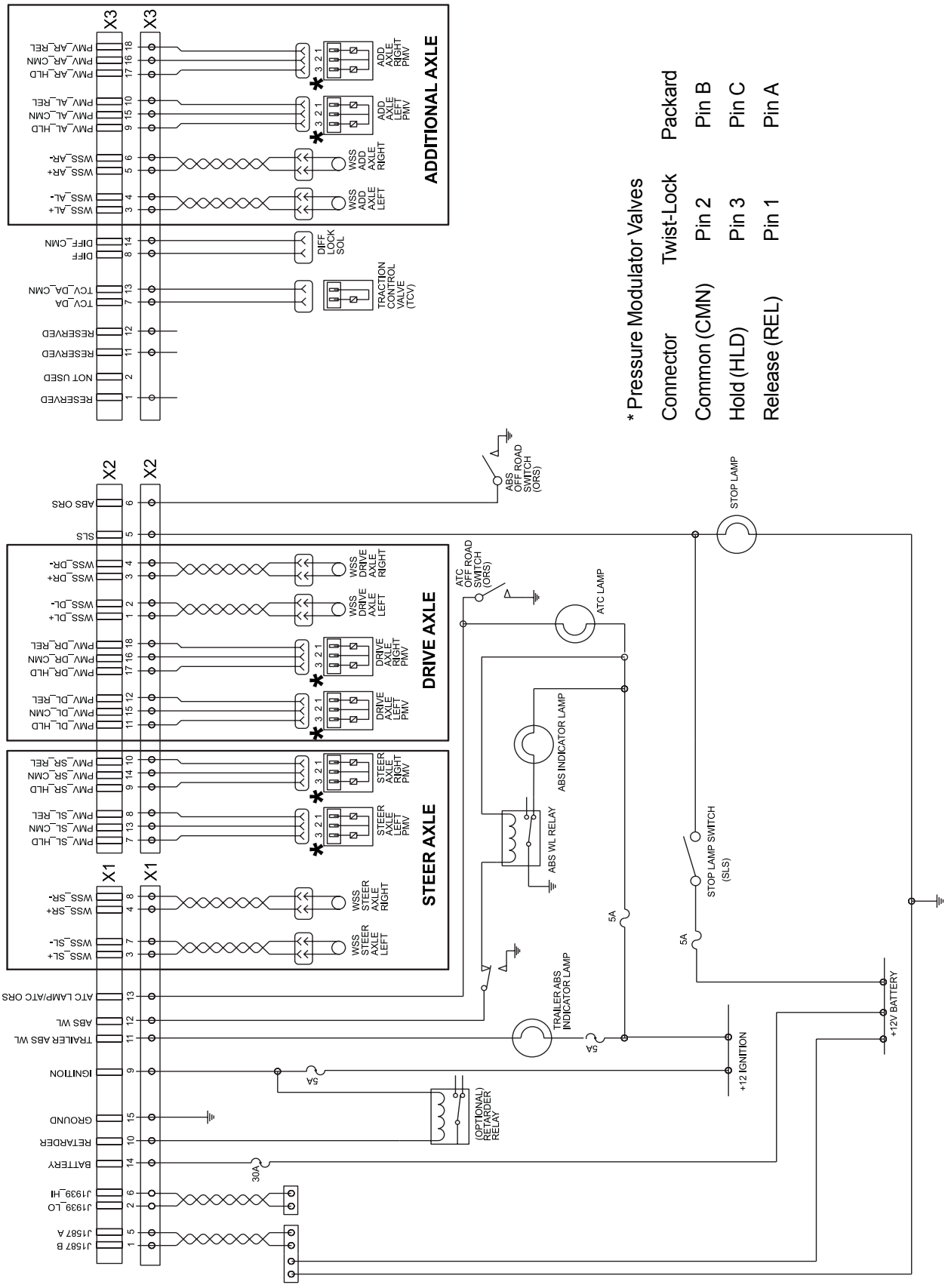

FIGURE 17 - PREMIUM FRAME WIRING SCHEMATIC (6S/6M)

Troubleshooting: Premium Frame Wiring Schematic (6S/5M)

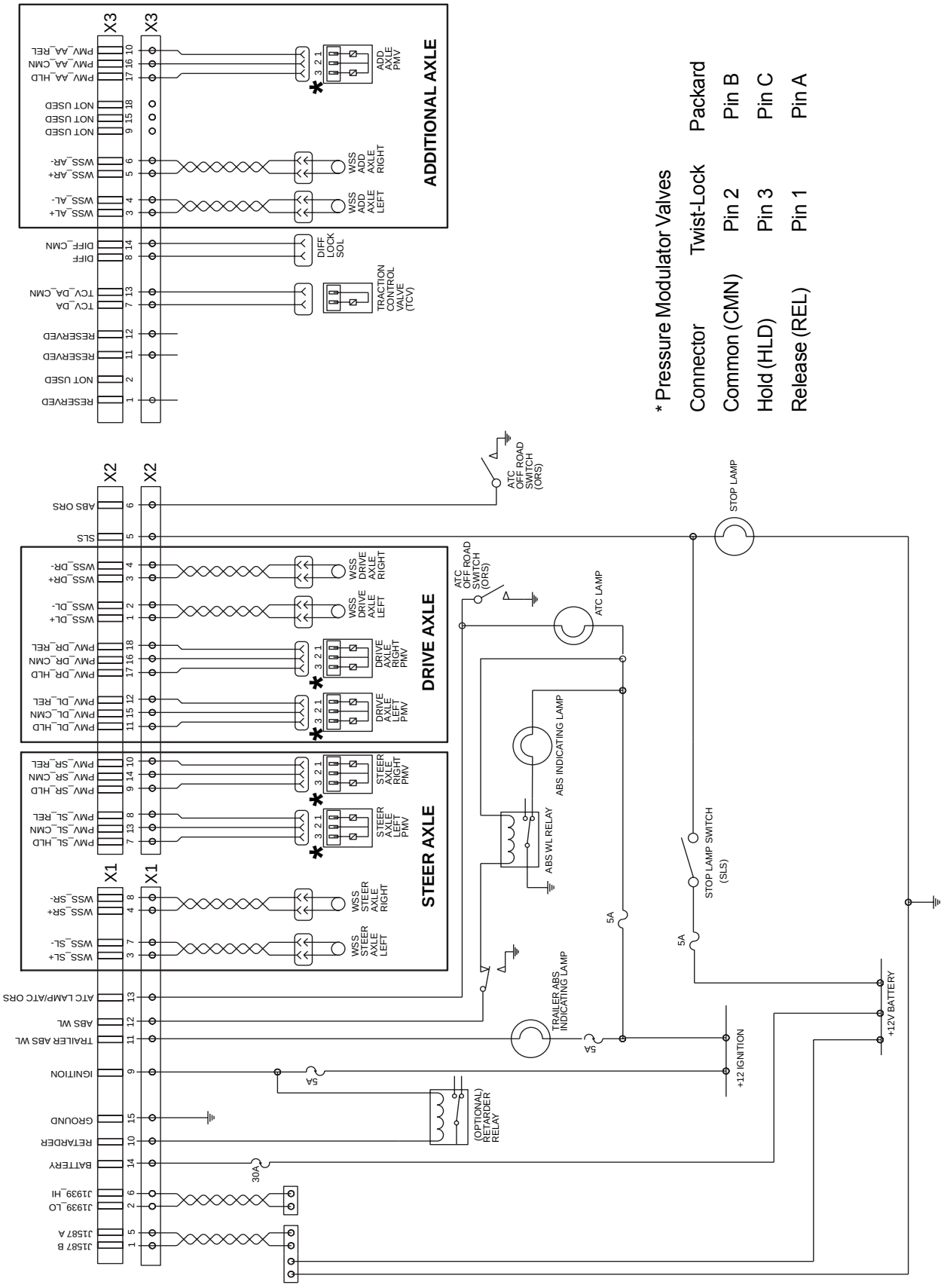

FIGURE 21 - PREMIUM FRAME WIRING SCHEMATIC (6S/5M)

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Glossary

ABS — Antilock Brake System.

ABS Event — Impending wheel lock situation that causes the ABS controller to activate the modulator valve(s).

ABS Indicator Light — An amber light which indicates the operating status of an antilock system. When the indicator lamp is on, ABS is disabled and the vehicle reverts to normal brake operation.

Air Gap — Distance between the Sensor and tone ring.

ASR — Automatic Slip Regulation. Another name for traction control.

ATC — Automatic Traction Control. An additional ABS function in which engine torque is controlled and brakes are applied differentially to enhance vehicle traction.

ATC Light — A light that indicates when traction control is operating.

Channel — A controlled wheel site.

CAN — Controller Area Network. J1939 is an SAE version of the CAN link.

Clear Codes — System to erase historical diagnostic trouble codes from the ECU, from either the Diagnostic Switch or from a hand-held diagnostic tool (only repaired diagnostic trouble codes may be cleared).

Configuration — The primary objective is to identify a “normal” set of sensors and modulators for the Electronic Control Unit, so that it will identify future missing sensors and modulators.

Diagnostic Connector — Diagnostic receptacle in vehicle cab for connection of J1587 hand-held or PC based test equipment. The tester can initiate test sequences, and can also read system parameters.

Diagnostic Switch — A switch used to activate blinks codes.

Differential Braking — Application of brake force to a spinning wheel so that torque can be applied to wheels which are not slipping.

ECU — Electronic Control Unit.

Diagnostic Trouble Code — A condition that interferes with the generation or transmission of response or control signals in the vehicle's ABS system that could lead to the functionality of the ABS system becoming inoperable in whole or in part.

FMVSS-121 — Federal Motor Vehicle Safety Standard which regulates air brake systems.

IR — Independent Regulation. A control method in which a wheel is controlled at optimum slip, a point where retardation and stability are maximized. The brake pressure that is best for the wheel in question is directed individually into each brake chamber.

J1587 — The SAE heavy duty standard diagnostic data link.

J1708 — An SAE standard which defines the hardware and software protocol for implementing 9600 baud heavy vehicle data links. J1587 version of a J1708 data link.

J1939 — A high speed 250,000 baud data link used for communications between the ABS ECU engine, transmission and retarders.

MIR — Modified Independent Regulation. A method of controlling the opposite sides of a steer axle during ABS operation so that torque steer and stopping distance are minimized.

PLC — Power Line Carrier. The serial communication protocol used to communicate with the trailer over the blue full time power wire.

PMV — Pressure Modulator Valve. An air valve which is used to vent or block air to the brake chambers to limit or reduce brake torque.

QR — Quick Release. Quick release valves allow faster release of air from the brake chamber after a brake application. To balance the system, quick release valves have hold off springs that produce higher crack pressures (when the valves open).

Relay Valve — Increases the application speed of the service brake. Installed near brakes with larger air chambers (type 24 or 30). The treadle valve activates the relay valve with an air signal. The relay valve then connects its supply port to its delivery ports. Equal length air hose must connect the delivery ports of the relay valve to the brake chambers.

Retarder Relay — A relay which is used to disable a retarder when ABS is triggered.

Sensor Clamping Sleeve — A beryllium copper sleeve which has fingers cut into it. It is pressed between an ABS sensor and mounting hole to hold the sensor in place.

Stored Diagnostic Trouble Codes — A diagnostic trouble code that occurred.

TCS — Traction Control System, another name for ATC or ASR.

Tone Ring — A ring that is usually pressed into a wheel hub that has a series of teeth (usually 100) and provides actuation for the speed sensor. Note maximum run out is .008.

Appendix A: J1587 SID and FMI Codes and Their Bendix Blink Code Equivalents

SID (J1587)	FMI (J1587)	General	Bendix Blink Code Equivalent(s) (1st Digit)	(2nd Digit)	Diagnostic Trouble Code Description
1	1	Wheel Speed Sensor	2	1	SA Left WSS Excessive Air Gap
1	2	Wheel Speed Sensor	2	3	SA Left WSS Open or Shorted
1	7	Wheel Speed Sensor	2	5	SA Left WSS Wheel End
1	8	Wheel Speed Sensor	2	6	SA Left WSS Erratic Sensor Signal
1	10	Wheel Speed Sensor	2	4	SA Left WSS Loss of Sensor Signal
1	13	Wheel Speed Sensor	2	7	SA Left WSS Tire Size Calibration
1	14	Wheel Speed Sensor	2	2	SA Left WSS Output Low @ Drive-Off
2	1	Wheel Speed Sensor	3	1	SA Right WSS Excessive Air Gap
2	2	Wheel Speed Sensor	3	3	SA Right WSS Open or Shorted
2	7	Wheel Speed Sensor	3	5	SA Right WSS Wheel End
2	8	Wheel Speed Sensor	3	6	SA Right WSS Erratic Sensor Signal
2	10	Wheel Speed Sensor	3	4	SA Right WSS Loss of Sensor Signal
2	13	Wheel Speed Sensor	3	7	SA Right WSS Tire Size Calibration
2	14	Wheel Speed Sensor	3	2	SA Right WSS Output Low @ Drive-Off
3	1	Wheel Speed Sensor	4	1	DA Left WSS Excessive Air Gap
3	2	Wheel Speed Sensor	4	3	DA Left WSS Open or Shorted
3	7	Wheel Speed Sensor	4	5	DA Left WSS Wheel End
3	8	Wheel Speed Sensor	4	6	DA Left WSS Erratic Sensor Signal
3	10	Wheel Speed Sensor	4	4	DA Left WSS Loss of Sensor Signal
3	13	Wheel Speed Sensor	4	7	DA Left WSS Tire Size Calibration
3	14	Wheel Speed Sensor	4	2	DA Left WSS Output Low @ Drive-Off
4	1	Wheel Speed Sensor	5	1	DA Right WSS Excessive Air Gap
4	2	Wheel Speed Sensor	5	3	DA Right WSS Open or Shorted
4	7	Wheel Speed Sensor	5	5	DA Right WSS Wheel End
4	8	Wheel Speed Sensor	5	6	DA Right WSS Erratic Sensor Signal
4	10	Wheel Speed Sensor	5	4	DA Right WSS Loss of Sensor Signal
4	13	Wheel Speed Sensor	5	7	DA Right WSS Tire Size Calibration
4	14	Wheel Speed Sensor	5	2	DA Right WSS Output Low @ Drive-Off
5	1	Wheel Speed Sensor	14	1	AA Left WSS Excessive Air Gap
5	2	Wheel Speed Sensor	14	3	AA Left WSS Open or Shorted
5	7	Wheel Speed Sensor	14	5	AA Left WSS Wheel End
5	8	Wheel Speed Sensor	14	6	AA Left WSS Erratic Sensor Signal
5	10	Wheel Speed Sensor	14	4	AA Left WSS Loss of Sensor Signal
5	13	Wheel Speed Sensor	14	7	AA Left WSS Tire Size Calibration
5	13	Wheel Speed Sensor	14	10	AA Left WSS Configuration Error
5	14	Wheel Speed Sensor	14	2	AA Left WSS Output Low @ Drive-Off
6	1	Wheel Speed Sensor	15	1	AA Right WSS Excessive Air Gap
6	2	Wheel Speed Sensor	15	3	AA Right WSS Open or Shorted
6	7	Wheel Speed Sensor	15	5	AA Right WSS Wheel End
6	8	Wheel Speed Sensor	15	6	AA Right WSS Erratic Sensor Signal
6	10	Wheel Speed Sensor	15	4	AA Right WSS Loss of Sensor Signal
6	13	Wheel Speed Sensor	15	7	AA Right WSS Tire Size Calibration
6	13	Wheel Speed Sensor	15	10	AA Right WSS Configuration Error
6	14	Wheel Speed Sensor	15	2	AA Right WSS Output Low @ Drive-Off
7	5	Pressure Modulator Valve	7	7	SA Left PMV CMN Open Circuit
7	13	Pressure Modulator Valve	7	8	SA Left PMV Configuration Error
8	5	Pressure Modulator Valve	8	7	SA Right PMV CMN Open Circuit
8	13	Pressure Modulator Valve	8	8	SA Right PMV Configuration Error
9	5	Pressure Modulator Valve	9	7	DA Left PMV CMN Open Circuit
9	13	Pressure Modulator Valve	9	8	DA Left PMV Configuration Error
10	5	Pressure Modulator Valve	10	7	DA Right PMV CMN Open Circuit
10	13	Pressure Modulator Valve	10	8	DA Right PMV Configuration Error
11	5	Pressure Modulator Valve	16	7	AA Left PMV CMN Open Circuit
11	13	Pressure Modulator Valve	16	8	AA Left PMV Configuration Error
12	5	Pressure Modulator Valve	17	7	AA Right PMV CMN Open Circuit
12	13	Pressure Modulator Valve	17	8	AA Right PMV Configuration Error
13	2	Miscellaneous	12	4	Retarder Relay Open Circuit or Shorted to Ground
13	3	Miscellaneous	12	5	Retarder Relay Circuit Shorted to Voltage
17	14	Miscellaneous	12	3	Dynamometer Test Mode
17	14	Miscellaneous	12	9	ATC Disabled to Prevent Brake Fade
18	13	TCV	18	4	TCV Configuration Error
18	3	TCV	18	2	TCV Solenoid Shorted to Voltage
18	4	TCV	18	1	TCV Solenoid Shorted to Ground
18	5	TCV	18	3	TCV Solenoid Open Circuit
22	7	Miscellaneous	12	11	Wheel Speed Sensors Reversed on an Axle
23	2	Miscellaneous	12	6	ABS Warning Lamp Circuit

SID (J1587)	FMI (J1587)	General	Bendix Blink Code Equivalent(s) (1st Digit)	(2nd Digit)	Diagnostic Trouble Code Description
42	3	Pressure Modulator Valve	7	5	SA Left PMV HLD Solenoid Shorted to Voltage
42	4	Pressure Modulator Valve	7	4	SA Left PMV HLD Solenoid Shorted to Ground
42	5	Pressure Modulator Valve	7	6	SA Left PMV HLD Solenoid Open Circuit
43	3	Pressure Modulator Valve	8	5	SA Right PMV HLD Solenoid Shorted to Voltage
43	4	Pressure Modulator Valve	8	4	SA Right PMV HLD Solenoid Shorted to Ground
43	5	Pressure Modulator Valve	8	6	SA Right PMV HLD Solenoid Open Circuit
44	3	Pressure Modulator Valve	9	5	DA Left PMV HLD Solenoid Shorted to Voltage
44	4	Pressure Modulator Valve	9	4	DA Left PMV HLD Solenoid Shorted to Ground
44	5	Pressure Modulator Valve	9	6	DA Left PMV HLD Solenoid Open Circuit
45	3	Pressure Modulator Valve	10	5	DA Right PMV HLD Solenoid Shorted to Voltage
45	4	Pressure Modulator Valve	10	4	DA Right PMV HLD Solenoid Shorted to Ground
45	5	Pressure Modulator Valve	10	6	DA Right PMV HLD Solenoid Open Circuit
46	3	Pressure Modulator Valve	16	5	AA Left PMV HLD Solenoid Shorted to Voltage
46	4	Pressure Modulator Valve	16	4	AA Left PMV HLD Solenoid Shorted to Ground
46	5	Pressure Modulator Valve	16	6	AA Left PMV HLD Solenoid Open Circuit
47	3	Pressure Modulator Valve	17	5	AA Right PMV HLD Solenoid Shorted to Voltage
47	4	Pressure Modulator Valve	17	4	AA Right PMV HLD Solenoid Shorted to Ground
47	5	Pressure Modulator Valve	17	6	AA Right PMV HLD Solenoid Open Circuit
48	3	Pressure Modulator Valve	7	2	SA Left PMV REL Solenoid Shorted to Voltage
48	4	Pressure Modulator Valve	7	1	SA Left PMV REL Solenoid Shorted to Ground
48	5	Pressure Modulator Valve	7	3	SA Left PMV REL Solenoid Open Circuit
49	3	Pressure Modulator Valve	8	2	SA Right PMV REL Solenoid Shorted to Voltage
49	4	Pressure Modulator Valve	8	1	SA Right PMV REL Solenoid Shorted to Ground
49	5	Pressure Modulator Valve	8	3	SA Right PMV REL Solenoid Open Circuit
50	3	Pressure Modulator Valve	9	2	DA Left PMV REL Solenoid Shorted to Voltage
50	4	Pressure Modulator Valve	9	1	DA Left PMV REL Solenoid Shorted to Ground
50	5	Pressure Modulator Valve	9	3	DA Left PMV REL Solenoid Open Circuit
51	3	Pressure Modulator Valve	10	2	DA Right PMV REL Solenoid Shorted to Voltage
51	4	Pressure Modulator Valve	10	1	DA Right PMV REL Solenoid Shorted to Ground
51	5	Pressure Modulator Valve	10	3	DA Right PMV REL Solenoid Open Circuit
52	3	Pressure Modulator Valve	16	2	AA Left PMV REL Solenoid Shorted to Voltage
52	4	Pressure Modulator Valve	16	1	AA Left PMV REL Solenoid Shorted to Ground
52	5	Pressure Modulator Valve	16	3	AA Left PMV REL Solenoid Open Circuit
53	3	Pressure Modulator Valve	17	2	AA Right PMV REL Solenoid Shorted to Voltage
53	4	Pressure Modulator Valve	17	1	AA Right PMV REL Solenoid Shorted to Ground
53	5	Pressure Modulator Valve	17	3	AA Right PMV REL Solenoid Open Circuit
55	2	Miscellaneous	12	2	Stop Lamp Switch Defective
55	7	Miscellaneous	12	1	Stop Lamp Switch Not Detected
79	13	Miscellaneous	12	10	Tire Size Out of Range (Front to Rear)
93	3	Miscellaneous	12	8	PMV/TCV/Diff Lock Common Shorted to Voltage
93	4	Miscellaneous	12	7	PMV/TCV/Diff Lock Common Shorted to Ground
102	3	Miscellaneous	12	13	Diff Lock Solenoid Shorted to Voltage
102	5	Miscellaneous	12	12	Diff Lock Solenoid Shorted to Ground or Open Circuit
231	2	J1939	11	3	J1939 Engine Communications
231	12	J1939	11	1	J1939 Serial Link
231	14	J1939	11	2	J1939 Retarder
251	2	Power Supply	6	8	Input Voltage Has Excessive Noise (Temp)
251	3	Power Supply	6	2	Battery Voltage Too High
251	3	Power Supply	6	6	Ignition Voltage Too High
251	4	Power Supply	6	1	Battery Voltage Too Low
251	4	Power Supply	6	3	Battery Voltage Too Low During ABS
251	4	Power Supply	6	5	Ignition Voltage Too Low
251	4	Power Supply	6	7	Ignition Voltage Too Low During ABS
251	5	Power Supply	6	4	Battery Voltage Input Open Circuit
251	14	Power Supply	6	9	Input Voltage Has Excessive Noise
254	2	ECU	13	4	ECU (12)
254	2	ECU	13	5	ECU (13)
254	12	ECU	13	2	ECU (10)
254	12	ECU	13	3	ECU (11)
254	12	ECU	13	6	ECU (14)
254	12	ECU	13	7	ECU (15)
254	12	ECU	13	10	ECU (18)
254	12	ECU	13	11	ECU (1A)
254	12	ECU	13	12	ECU (1B)
254	12	ECU	13	13	ECU (80)
254	13	ECU	13	8	ECU (16)
254	13	ECU	13	9	ECU (17)

Bendix

Service Data

SD-08-2418

Bendix® AD-IS® Air Dryer and Reservoir System

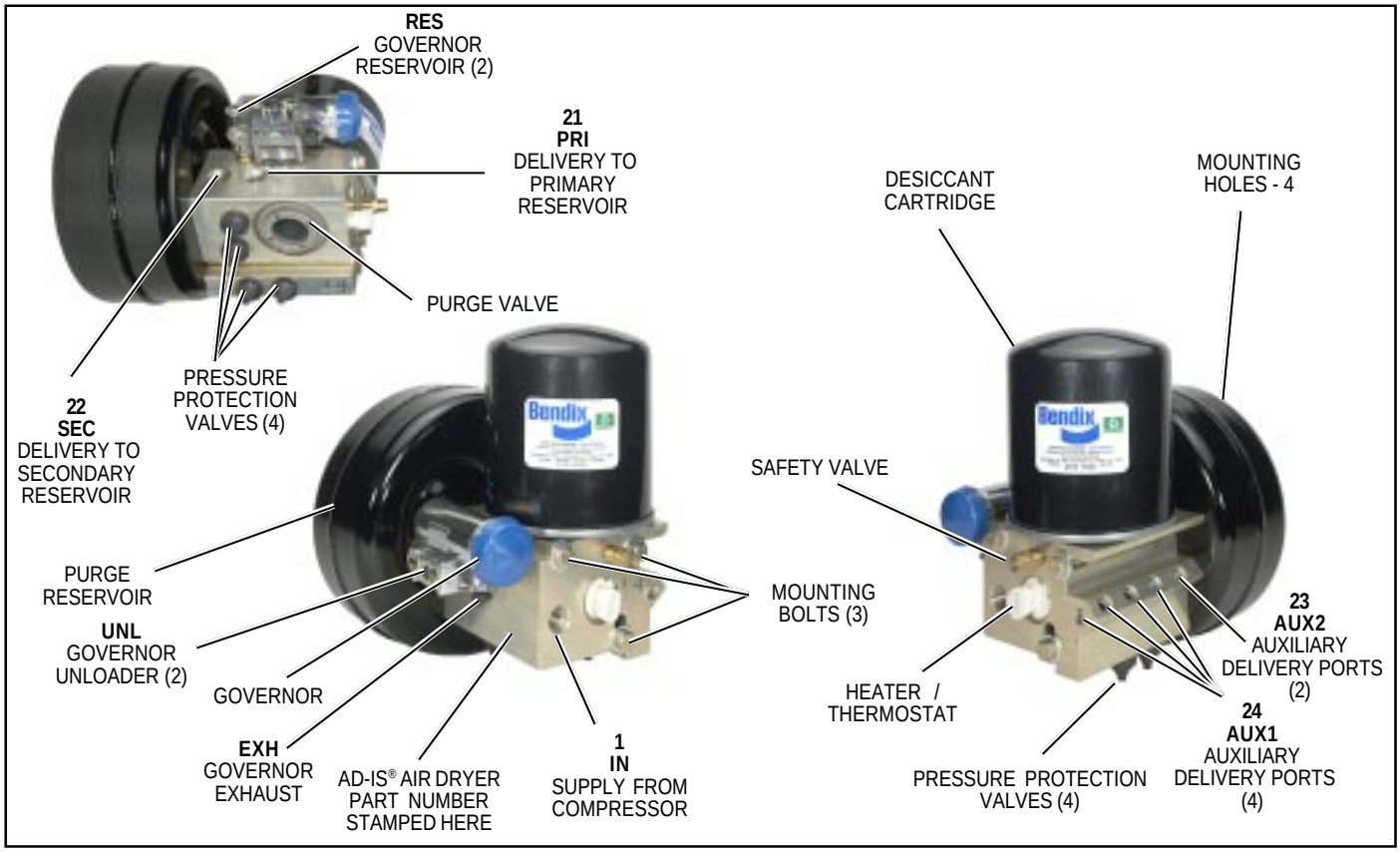


*FIGURE 1 - **AD-IS® AIR DRYER AND RESERVOIR SYSTEM***

DESCRIPTION

The function of the **I**ntegrated **S**olution **A**ir **D**ryer (**AD-IS®**) and Reservoir System is to provide heavy vehicles with an integrated vehicle air dryer, purge reservoir, governor and a number of the charging valve components in a module. These have been designed as an integrated air supply system.

The AD-IS® air dryer and reservoir system collects and removes air system contaminants in solid, liquid and vapor form before they enter the brake system. It provides clean, dry air to the components of the brake system which increases the life of the system and reduces maintenance costs. The necessity for daily manual draining of the reservoirs is eliminated.

Air Connection Port ID	Function/Connection	QTY
1 IN	Inlet Port (air in).	1
21 PRI	Delivery Port out (to Primary reservoir)	1
22 SEC	Delivery Port out (to Secondary reservoir)	1
24 AUX 1	Auxiliary Delivery Port (air out).	4
23 AUX 2	Auxiliary Delivery Port (air out).	1
UNL	Unloader Control Air (D-2A™ Governor)	2
RES	Common Reservoir Pressure (D-2A™ Governor)	2
EXH	Governor Exhaust	1

*TABLE 1 - **PORT DESIGNATIONS***

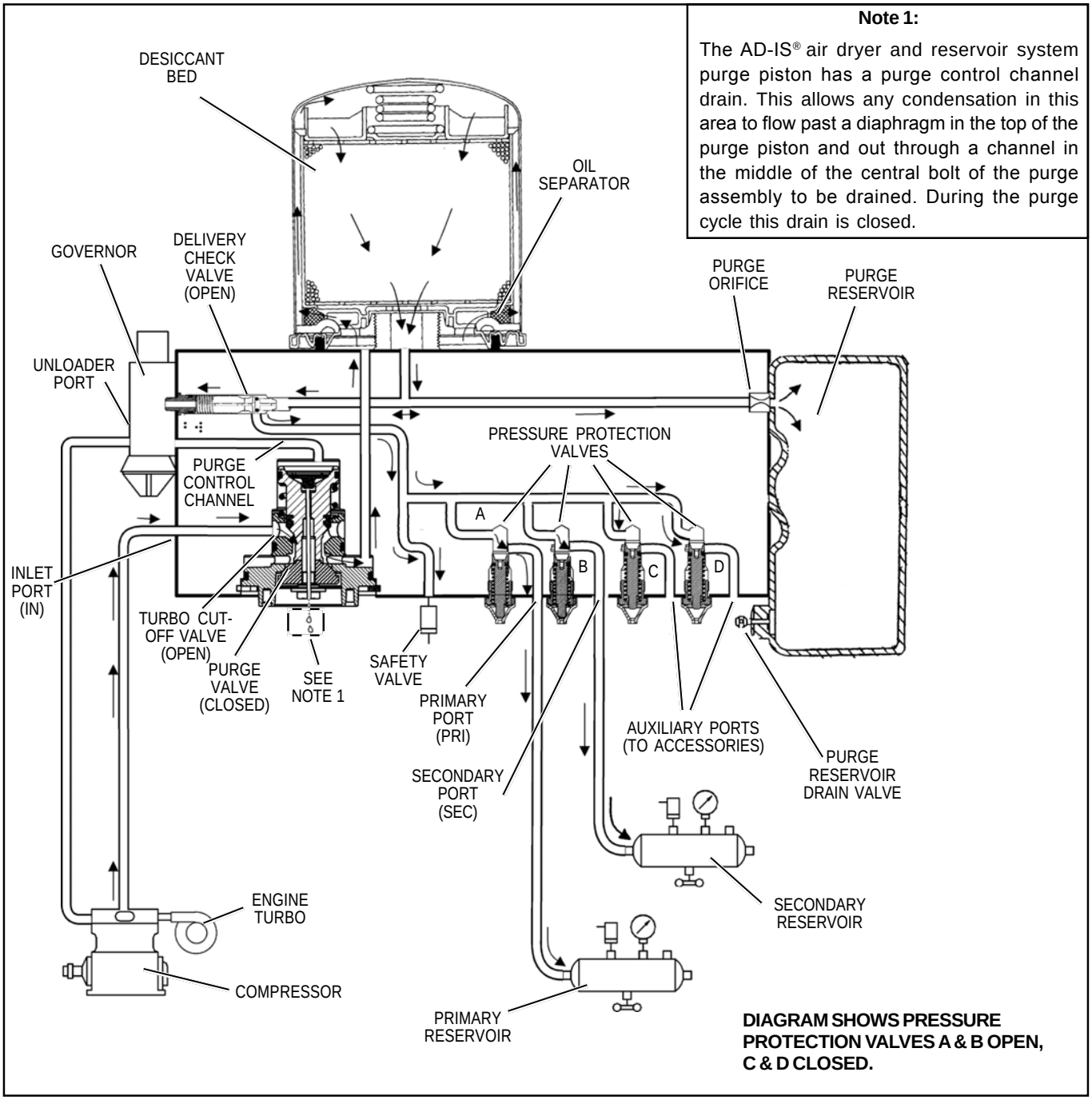


FIGURE 2 - ***AD-IS® AIR DRYER AND RESERVOIR SYSTEM CHARGE CYCLE***

The function of the pressure protection valves is to protect each reservoir from a pressure loss in the other reservoir or a pressure loss in an air accessory. Each of the pressure protection valves in the AD-IS® air dryer and reservoir system may have different pressure settings, but these are factory set and must not be changed or adjusted.

The air dryer and reservoir system consists of a “spin on” desiccant cartridge secured to a base assembly. The base assembly contains a delivery check valve assembly, safety valve, heater and thermostat assembly, pressure protection valves, threaded air connections and the purge valve assembly.

The removable purge valve assembly incorporates the purge valve mechanism and a turbocharger cut-off feature that is designed to prevent loss of engine “turbo” boost pressure during the purge cycle of the AD-IS® air dryer and reservoir system. For ease of maintenance, all replaceable assemblies can be serviced without removal of the air dryer and reservoir system from its mounting on the vehicle. Refer to *Preventive Maintenance* section.

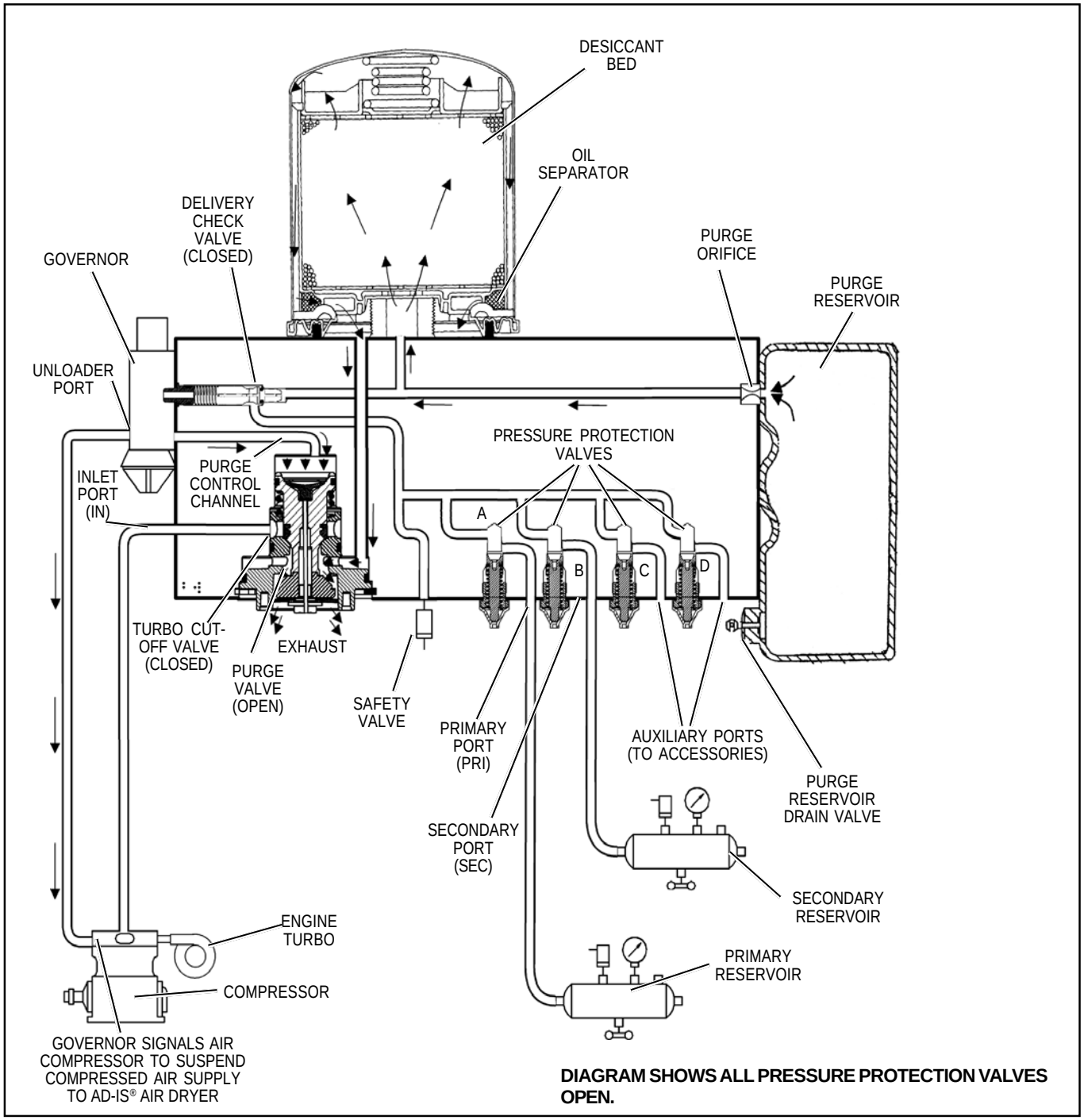


FIGURE 3 - ***AD-IS® AIR DRYER AND RESERVOIR SYSTEM PURGE CYCLE***

AD-IS® AIR DRYER AND RESERVOIR SYSTEM OPERATION: GENERAL (Refer to Figure 2)

The AD-IS® air dryer and reservoir system is designed to receive compressed air from the vehicle air compressor, clean and dry the air, deliver air to the vehicle's primary reservoir, secondary reservoir and accessories, and control the compressor/dryer charge cycle.

AIR DRYER AND RESERVOIR SYSTEM OPERATION: GENERAL

The AD-IS® air dryerand reservoir system alternates between two operational modes or "cycles" during operation: the Charge Cycle and the Purge Cycle. The following descriptions are separated into these "cycles" of operation.

CHARGE CYCLE (Refer to Figure 2)

When the compressor is loaded (compressing air) compressed air flows through the compressor discharge line to the inlet (1/IN) port of the air dryer body. The compressed air often includes contaminates such as oil, oil vapor, water and water vapor.

Traveling through the discharge line and into the air dryer, the temperature of the compressed air falls, causing some

of the contaminants to condense and drop to the bottom of the air dryer and reservoir system purge valve assembly, ready to be expelled at the next purge cycle. The air then flows into the desiccant cartridge, where it flows through an oil separator which removes liquid oil and solid contaminants.

Air then flows into the desiccant drying bed and becomes progressively drier as water vapor adheres to the desiccant material in a process known as "ADSORPTION."

Dry air exits the desiccant cartridge through the center of the base assembly. The air then flows to the delivery check valve and also through an orifice into the purge reservoir. The delivery check valve opens, supplying air to the pressure protection valves (A) through (D) simultaneously, the safety valve, and also to the reservoir port of the attached governor. The purge reservoir fills, storing air that will be used to reactivate the desiccant during the purge cycle. This air is available to supply downstream components during the charge mode.

When the air pressure reaches approximately 106 psi, the four pressure protection valves will open and air will be supplied to the primary reservoir, secondary reservoir and accessories. If the pressure protection valves are preset to different values the valves will open in order of lowest setting to highest setting when charging a flat system.

The air dryer and reservoir system will remain in the charge cycle until the air brake system pressure builds to the governor cut-out setting of approximately 130 p.s.i.

PURGE CYCLE (Refer to Figure 3.)

When air brake system pressure reaches the cut-out setting of the governor, the governor unloads the compressor and the purge cycle of the air dryer and reservoir system begins.

The governor unloads the compressor by allowing air pressure to fill the line leading to the compressor unloader mechanism - causing the delivery of compressed air to the AD-IS® air dryer and reservoir system to be suspended.

Similarly, the governor also supplies air pressure to the AD-IS® air dryer and reservoir system purge control channel. The AD-IS® air dryer and reservoir system purge piston moves down in response to this air pressure, causing the purge valve to open to the atmosphere and the turbo cut-off valve to close off the supply of air from the compressor (this will be further discussed in the *Turbo Cut-off Feature* section). Water and contaminants which have collected in the purge valve base are expelled immediately when the purge valve opens. Also, air which was flowing through the desiccant cartridge changes direction and begins to flow toward the open purge valve. Oil and solid contaminants collected by the oil separator are removed by air flowing from the purge reservoir through the desiccant drying bed to the open purge valve.

The initial purge and desiccant cartridge decompression lasts only a few seconds and is evidenced by an audible burst of air at the AD-IS® air dryer and reservoir system exhaust.

The actual reactivation of the desiccant drying bed begins as dry air from the purge reservoir flows through the purge orifice into the desiccant bed. Pressurized air from the purge reservoir expands after passing through the purge orifice; its pressure is lowered and its volume increased. The flow of dry air through the drying bed reactivates the desiccant material by removing the water vapor adhering to it. Approximately 30 seconds are required for the entire contents of the purge reservoir of a standard AD-IS® air dryer and reservoir system to flow through the desiccant drying bed.

The delivery check valve assembly prevents air pressure in the brake system from returning to the air dryer and reservoir system during the purge cycle. After the purge cycle is complete, the air dryer and reservoir system is ready for the next charge cycle to begin.

TURBO CUT-OFF FEATURE (Refer to Figure 3.)

The primary function of the turbo cut-off valve is to prevent loss of engine turbocharger air pressure through the AD-IS® air dryer and reservoir system when the dryer is in the unloaded mode.

At the onset of the purge cycle, the downward travel of the purge piston is stopped when the turbo cut-off valve (tapered portion of purge piston) contacts its mating metal seat in the purge valve housing. With the turbo cut-off valve seated (closed position), air in the compressor discharge line and AD-IS® air dryer and reservoir system inlet port cannot enter the air dryer and reservoir system. In this manner the turbo cut-off effectively maintains turbo charger boost pressure to the engine.

PREVENTIVE MAINTENANCE

Important: Review the warranty policy before performing any intrusive maintenance procedures. An extended warranty may be voided if intrusive maintenance is performed during this period. Purge valve maintenance is permissible during the warranty period only when using a genuine Bendix purge valve kit.

Because no two vehicles operate under identical conditions, maintenance and maintenance intervals will vary. Experience is a valuable guide in determining the best maintenance interval for any one particular operation.

Every 900 operating hours, or 25,000 miles or three (3) months:

1. Check for moisture in the air brake system by opening reservoir drain valves and checking for presence of water. If moisture is present, the desiccant cartridge

may require replacement; however, the following conditions can also cause water accumulation and should be considered before replacing the desiccant:

A. An outside air source has been used to charge the system. This air did not pass through the drying bed.

B. Air usage is exceptionally high and not normal for a highway vehicle.

This may be due to accessory air demands or some unusual air requirement that does not allow the compressor to load and unload (compressing and non-compressing cycle) in a normal fashion. Check for high air system leakage. If the vehicle vocation has changed it may be necessary to upgrade the compressor size. Refer to Bendix Specification BW-100-A, Appendix D to determine if any changes are necessary.

C. Location of the air dryer and reservoir system is too close to the air compressor. Refer to Bendix Specification BW-100-A, Appendix B for discharge line lengths.

D. In areas where more than a 30 degree range of temperature occurs in one day, small amounts of water can temporarily accumulate in the air brake system due to condensation. Under these conditions, the presence of small amounts of moisture is normal.

Note: A small amount of oil in the system is normal and should not be considered as a reason to replace the desiccant cartridge. Some oil at the dryer exhaust is normal.

2. Visually check for physical damage such as chaffed or broken air and electrical lines and broken or missing parts.
3. Check the AD-IS® air dryer and purge reservoir bolts for tightness. See Figure 1. Re-torque the three air dryer bolts to 360-420 inch pounds and the four purge reservoir bolts to 300-360 inch pounds.
4. Perform the *Operation & Leakage Tests* listed in this publication.

WARNING!

This air dryer and reservoir system is intended to remove moisture and other contaminants normally found in the air brake system. Do not inject alcohol, anti-freeze, or other de-icing substances into or upstream of the air dryer and reservoir system. Alcohol is removed by the dryer, but reduces the effectiveness of the device to dry air. Use of these or other substances can damage the air dryer and reservoir system and may void the warranty.

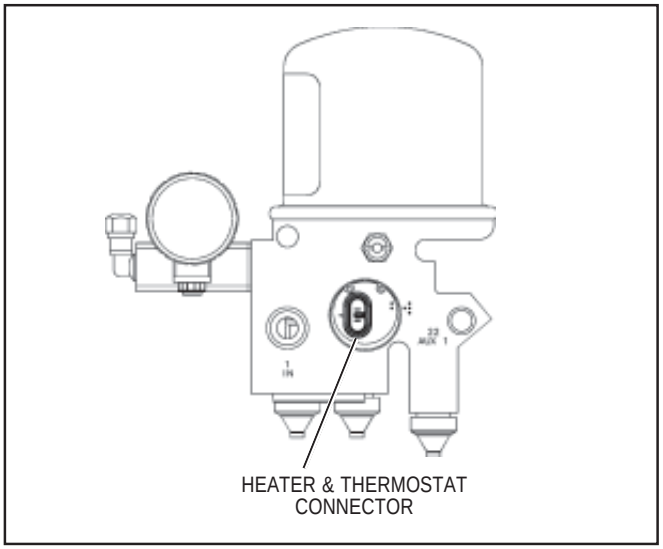


FIGURE 4 - ***AD-IS® AIR DRYER AND RESERVOIR SYSTEM HEATER AND THERMOSTAT CONNECTOR***

OPERATION & LEAKAGE TESTS (ALSO SEE VIDEO BW2327)

1. Check all lines and fittings leading to and from the air dryer and reservoir system for leakage and integrity. Repair any leaks found.
2. Build up system pressure to governor cut-out and note that the AD-IS® air dryer and reservoir system purges with an audible escape of air. Watch the system pressure and note the pressure fall-off for a ten minute period. If pressure drop exceeds, for a single vehicle - 1 psi/minute from either service reservoir; or for tractor trailer - 3 psi/minute from either service reservoir, inspect the vehicle air systems for sources of leakage and repair them. Refer to section entitled *Troubleshooting,* Symptoms 1 and 4.
3. **Caution: Be sure to wear safety glasses in case of a purge blast.** Check for excessive leakage around the purge valve with the compressor in the loaded mode (compressing air). Apply a soap solution to the purge valve exhaust port and observe that leakage does not exceed a 1" bubble in 1 second. If the leakage exceeds the maximum specified, refer to section entitled *Troubleshooting*, Symptom 4.
4. Build up system pressure to governor cut-out and note that the AD-IS® air dryer and reservoir system purges with an audible burst of air, followed immediately by approximately 30 seconds of air flowing out of the purge valve. "Fan" the service brakes to reduce system air pressure to governor cut-in. Note that the system once again builds to full pressure and is followed by an AD-IS® air dryer and reservoir system purge. If system does not follow this pattern, refer to section entitled *Troubleshooting*, Symptoms 5 and 6.
5. Check the operation of the end cover heater and thermostat assembly during cold weather operation as follows:

A. Electric Power to the Dryer

With the ignition or engine kill switch in the RUN position, check for voltage to the heater and thermostat assembly using a voltmeter or testlight. Unplug the electrical connector at the air dryer and reservoir system and place the test leads on each of the connections of the female connector on the vehicle power lead. If there is no voltage, look for a blown fuse, broken wires, or corrosion in the vehicle wiring harness. Check to see if a good ground path exists.

B. Thermostat and Heater Operation

Note: These tests are not possible except in cold weather operation.

Turn off the ignition switch and cool the thermostat and heater assembly to below 40 degrees Fahrenheit. Using an ohmmeter, check the resistance between the electrical pins in the air dryer and reservoir system connector half. The resistance should be 1.5 to 3.0 ohms for the 12 volt heater assembly and 6.0 to 9.0 ohms for the 24 volt heater assembly.

Warm the thermostat and heater assembly to approximately 90 degrees Fahrenheit and again check the resistance. The resistance should exceed 1000 ohms. If the resistance values obtained are within the stated limits, the thermostat and heater assembly is operating properly. If the resistance values obtained are outside the stated limits, replace the heater and thermostat assembly.

6. Pressure Protection Valves. Observe the pressure gauges of the vehicle as system pressure builds from zero. The primary or secondary gauge should rise until it reaches approximately 106 p.s.i. (±6 p.s.i.), then level off (or a momentary slight fall) as the next pressure protection valve opens supplying its reservoir. When that pressure gauge passes through approximately 106 p.s.i. (±6 p.s.i.) there should be an associated leveling off (or momentary slight fall) of pressure as the third and fourth pressure protection valves open. Then the primary and secondary gauges should increase together until they reach their full pressure of approximately 130 psi (±5 psi).

   If the AD-IS® air dryer and reservoir system does not perform within the pressure ranges as described above, recheck using gauges known to be accurate. If the readings remain outside of the ranges outlined above, replace the AD-IS® air dryer and reservoir system. **NOTE:** There are no kits available for the servicing of the pressure protection valves. **WARNING: Do not attempt to adjust or service the pressure protection valves - incorrect pressure protection valve settings can result in automatic application of the vehicle spring brakes without prior warning in the event one of the supply circuits experiences rapid pressure loss.**

REBUILDING THE AD-IS® AIR DRYER AND RESERVOIR SYSTEM

GENERAL SAFETY GUIDELINES

WARNING! PLEASE READ AND FOLLOW THESE INSTRUCTIONS TO AVOID PERSONAL INJURY OR DEATH:

When working on or around a vehicle, the following general precautions should be observed at all times.

1. **Park the vehicle on a level surface, apply the parking brakes, and always block the wheels. Always wear safety glasses.**
2. **Stop the engine and remove ignition key when working under or around the vehicle. When working in the engine compartment, the engine should be shut off and the ignition key should be removed. Where circumstances require that the engine be in operation, EXTREME CAUTION should be used to prevent personal injury resulting from contact with moving, rotating, leaking, heated or electrically charged components.**

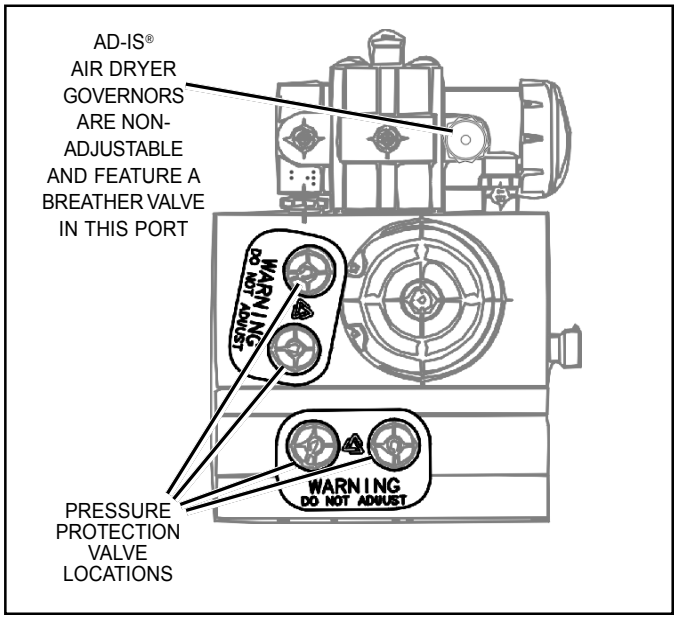


FIGURE 5 - ***PRESSURE PROTECTION VALVE LOCATIONS***

WARNING:

DO NOT ATTEMPT TO ADJUST OR SERVICE THE PRESSURE PROTECTION VALVES. INCORRECT PRESSURE PROTECTION VALVE SETTINGS CAN RESULT IN AUTOMATIC APPLICATION OF VEHICLE SPRING BRAKES WITHOUT PRIOR WARNING.

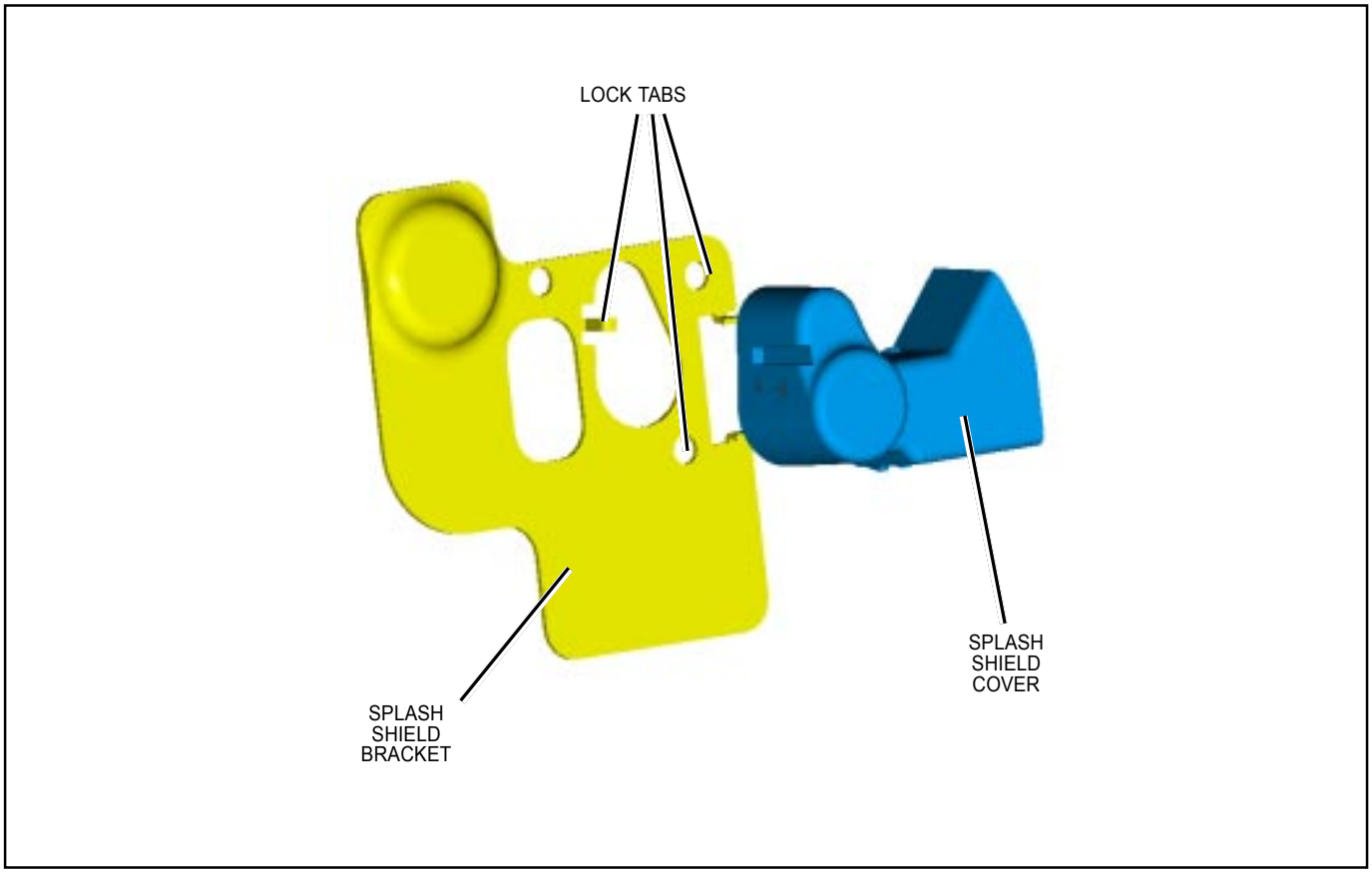


FIGURE 6 - ***SPLASH SHIELD BRACKET AND COVER - (EXPLODED VIEW)***

3. **Do not attempt to install, remove, disassemble or assemble a component until you have read and thoroughly understand the recommended procedures. Use only the proper tools and observe all precautions pertaining to use of those tools.**
4. **If the work is being performed on the vehicle's air brake system, or any auxiliary pressurized air systems, make certain to drain the air pressure from all reservoirs before beginning ANY work on the vehicle. If the vehicle is equipped with an AD-IS® air dryer system or a dryer reservoir module, be sure to drain the purge reservoir.**
5. **Following the vehicle manufacturer's recommended procedures, deactivate the electrical system in a manner that safely removes all electrical power from the vehicle.**
6. **Never exceed manufacturer's recommended pressures.**
7. **Never connect or disconnect a hose or line containing pressure; it may whip. Never remove a component or plug unless you are certain all system pressure has been depleted.**
8. **Use only genuine Bendix® replacement parts, components and kits. Replacement hardware, tubing, hose, fittings, etc. must be of equivalent size, type and strength as original equipment and be designed specifically for such applications and systems.**
9. **Components with stripped threads or damaged parts should be replaced rather than repaired. Do not attempt repairs requiring machining or welding unless specifically stated and approved by the vehicle and component manufacturer.**
10. **Prior to returning the vehicle to service, make certain all components and systems are restored to their proper operating condition.**
11. **For vehicles with Antilock Traction Control (ATC), the ATC function must be disabled (ATC indicator lamp should be ON) prior to performing any vehicle maintenance where one or more wheels on a drive axle are lifted off the ground and moving.**

GENERAL

When rebuilding or replacing components of the air dryer and reservoir system use only genuine Bendix parts. For ease in servicing, the AD-IS® air dryer and reservoir system has been designed so that any of the following maintenance kits can be installed without removing the air dryer and reservoir system from the vehicle. CAUTION: Always depressurize the air dryer and reservoir system purge reservoir, and all other reservoirs on the vehicle to 0 p.s.i. before servicing the air dryer and reservoir system.

If, after completing the routine operation and leakage tests, it has been determined that one or more components of the air dryer and reservoir system requires replacement or maintenance, refer to the following list to find the appropriate kit(s).

MAINTENANCE KITS AVAILABLE:

- **Service New Desiccant Cartridge Kit - Part Number 5008414:** This kit contains the parts necessary to change the desiccant cartridge only.
- **Delivery Check Valve Maintenance Kit - Part Number 5004052:** This kit contains the parts necessary to replace the delivery check valve.
- **Purge Valve Maintenance Kit - Part Number 5018313**: This kit contains the parts necessary to replace and relubricate the purge valve sealing rings.
- **Governor/Delivery Check Valve Kit - Part Number 5004049:** This kit contains the parts necessary to replace both the governor and delivery check valve.
- **12 volt or 24 volt Heater and Thermostat Kit - Part Numbers 109495 & 109496:** Contains a replacement heater and thermostat assembly and related components required for replacement.
- **Purge Valve Housing Rebuild Kit - Part Number 500354**7: This kit contains the parts necessary to rebuild the purge valve sub-assembly.
- **Service New Purge Valve Housing Assembly - Part Number 800404**: Contains a service new assembly and related components to change the purge valve sub-assembly.
- **Pressure Protection Valve Boot Replacement- Part Number 5005163.**
- **AD-IS® Air Dryer Replacement:** Replaces the complete air dryer assembly. Includes air dryer assembly and governor.
- **AD-IS® Air Dryer Splash Shield Replacement Kit - Part Number 5006698.**
- **Purge Reservoir Drain Valve:** Replaces the drain valve on the purge reservoir.

SEE THE AD-IS® AIR DRYER CATALOG PAGE (STARTING ON PAGE 08-A-24) FOR A FULL LIST OF MAINTENANCE KITS AVAILABLE.

NOTE: Kits are not available for the servicing of the pressure protection valves (See Figure 5). Do not attempt to adjust or service the pressure protection valves - these are not service items.

TESTING THE AD-IS® AIR DRYER AND RESERVOIR SYSTEM

Before placing the vehicle in service, perform the following tests:

1. Close all reservoir drain valves.
2. Build up system pressure to governor cut-out and note that the AD-IS® air dryer and reservoir system purges with an audible burst of air, followed immediately by approximately 30 seconds of air flowing out of the purge valve.
3. "Fan" the service brakes to reduce system air pressure to governor cut-in. Note that the system once again builds to full pressure and is followed by a purge at the AD-IS® air dryer and reservoir system exhaust.
4. It is recommended that the total air system be tested for leakage to assure that the AD-IS® air dryer and reservoir system will not cycle excessively.

   See Bendix publication BW5057 "Air Brake Handbook."

BRAKING SYSTEM PROTECTION

The AD-IS® air dryer and reservoir system allows the system to maintain one brake circuit up to about 100 psi even after a pressure loss in the other brake circuit. This allows a vehicle to be moved (in an emergency), but with reduced braking capacity. Compare this to a conventional system where a loss of pressure in one service tank leaves the vehicle with a limited number of reduced braking capacity applications before the parking brakes automatically apply and stay on.

ROADSIDE INSPECTION

In the event of a roadside inspection the system behavior will be as follows: When the system is charged to governor cut-out, and then one reservoir drain valve is opened, initially both reservoir gauges will fall, however, the AD-IS® air dryer and reservoir system primary and secondary pressure protection valves will close at pressures above 70 psi, protecting the remaining brake circuit from further loss of pressure.

TEMPORARY AIR DRYER AND RESERVOIR SYSTEM BYPASS

To temporarily bypass the air dryer, the following procedure needs to be followed:

Follow the *Maintenance Precautions* outlined elsewhere in this document.

Make sure that all residual pressure has been released and the air dryer purge reservoir has been drained to 0 p.s.i., then remove the air supply line from the compressor to the inlet port (1/IN). Remove the safety valve from the AD-IS® air dryer and reservoir system body (see Figure 1 for location). Note that a short puff of trapped air may vent from the safety valve port when the valve is being removed. Install a T-fitting into the port. Using any adapters necessary, reinstall the safety valve in one of the branches of the T-fitting. Using any adapters necessary, install the air supply line into the remaining T-fitting port. After testing the T-fitting for any air leakage, by using a soap solution after charging to system

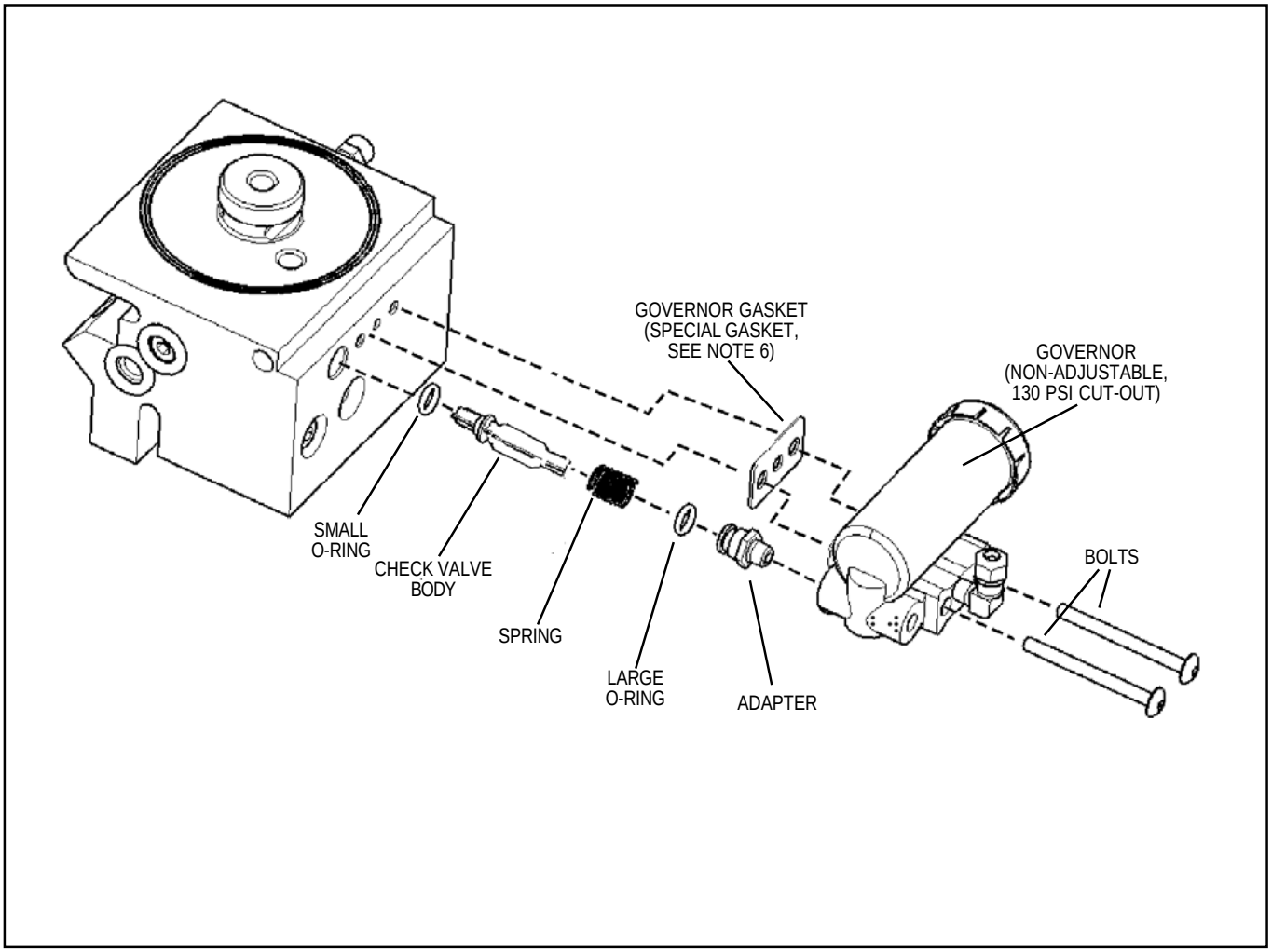


FIGURE 7 - ***AD-IS® AIR DRYER AND RESERVOIR SYSTEM DELIVERY CHECK VALVE***

cut-out pressure (a 1" bubble in 10 seconds is acceptable), the vehicle may be returned to temporary service.

Note: This is a temporary bypass of the air dryer, and full repair of the unit must be carried out at the earliest opportunity. With the air dryer and reservoir system removed from the system, contaminants will be entering the air system: reservoirs will need to be manually drained daily until the repairs are completed. At end of each working day, park vehicle and slowly drain pressure through the drain valves – leave open to the atmosphere, for several hours if possible. When repairs are carried out, be sure to check that all reservoirs (including the air dryer purge reservoir) are emptied of all contaminants.

If after bypassing the air dryer and reservoir system the system pressure still does not build, use the following procedure to remove, clean and reinstall the delivery check valve.

DELIVERY CHECK VALVE CLEANING PROCEDURE

(Note: This is only required if system pressure does not build after temporary bypass is completed.)

See Figure 7 throughout this procedure. Depressurize the air brake system following the general safety precautions outlined elsewhere in this document. Also, always depressurize the air dryer purge reservoir before servicing the air dryer.

This procedure does not require removal of the AD-IS® air dryer and reservoir system from the vehicle.

1. Remove the line from the governor and mark for easy reinstallation.
2. Remove the bolts attaching the governor to the AD-IS® air dryer and reservoir system and retain for reassembly.
3. Remove the governor from the air dryer. Be aware that a short puff of trapped air may vent when the governor is removed. Retain the governor gasket for reassembly if a new governor gasket is not available. Remove and retain the o-ring from the adapter.
4. The spring/delivery check valve can now be removed.
5. Remove and retain the o-ring from check valve body.

CLEANING & INSPECTION

1. Use a suitable solvent to clean all metal parts, and use a cotton swab to clean the bore (Note: Do not use abrasives or tools to clean the bore: any scratches caused may necessitate replacing the AD-IS® air dryer and reservoir system.) Superficial external corrosion and/or pitting is acceptable.
2. Clean the o-rings with a clean dry cloth. Do not use solvents.
3. Inspect for physical damage to the bore and the check valve seat. If the bore is damaged (by scratches etc. that would prevent delivery check valve from seating), replace the AD-IS® air dryer.
4. Inspect the delivery check valve, o-rings, etc. for wear or damage. Replace if necessary using the check valve replacement kit available at authorized Bendix parts outlets.
5. Inspect all air line fittings for corrosion and replace as necessary.

ASSEMBLY

1. Lubricate the smaller o-ring and check valve body with Bendix supplied barium or silicon grease.
2. Install this o-ring on the check valve body by sliding the o-ring over the set of 4 tapered guide lands. The o-ring groove holds the o-ring in its correct location.
3. At the other end of the check valve body, the spring is installed over the set of 4 straight guide lands. When the spring has been pushed to the correct location, the check valve body is designed to hold the end of the spring in position - be sure that the spring is not loose before continuing with this installation.
4. Install the assembled check valve body/o-ring/spring in the delivery port so that the o-ring rests on its seat and the free end of the spring is visible.
5. Grease the adapter and the remaining larger o-ring and install it onto the fitting.
6. Position the Bendix supplied gasket, then insert the governor mounting bolts through the governor and tighten (to 125 in-lbs). **(Note: Do not replace with a standard compressor/governor gasket.)**
7. Reattach line to the governor.
8. Before placing vehicle back into service, check to see that the system pressure now builds to full operational pressure.

AD-IS® AIR DRYER AND RESERVOIR SYSTEM TROUBLESHOOTING CHART

SYMPTOM	CAUSE	REMEDY
1. Dryer is constantly "cycling" or purging.	A. Excessive system leakage.	A. Test for excessive system leakage. Allowable leakage observed at dash gauge: Single vehicle - 1 psi/minute. Tractor trailer - 3 psi/minute. Using soap solution, test vehicle for leakage at fittings, drain valves and system valves. Repair or replace as necessary.
	B. Defective delivery check valve.	B. Build system pressure to governor cut-out. Wait 1 minute for completion of purge cycle. Using soap solution at exhaust of purge valve, leakage should not exceed a 1" bubble in less than 5 seconds. If a rapid loss of pressure is found, the following procedure will determine if the delivery check valve is malfunctioning: Build system pressure to governor cut-out and allow a full minute for the normal dryer purge cycle to empty the purge reservoir. Switch off the engine and "fan" the brakes so that the system pressure reaches governor cut-in. The purge valve will return to its closed position. The purge reservoir has a drain valve which is opened by moving the center lever away from its closed position. Open the drain valve and wait 10 seconds to allow any residual purge pressure to be released. Release the lever, closing the drain valve. Carefully remove the air dryer cartridge using a strap wrench and then test for air leaking through the center of the threaded boss by applying a soap solution to the boss. Replace the delivery check valve if there is excessive leakage (exceeding a 1" bubble in 5 seconds). Regrease the seal on the air dryer cartridge before reinstalling. Be sure the drain valve on the purge reservoir is not leaking before restoring vehicle to service.
	C. Defective governor.	C. Check governor at both "cut-in" and "cut-out" position for (i) proper pressures and (ii) excessive leakage at fittings and exhaust.
	D. Compressor unloader mechanism leaking excessively.	D. Remove air strainer or fitting from compressor inlet cavity. With compressor unloaded, check for unloader piston leakage. Slight leakage is permissible.

TROUBLESHOOTING CHART (Continued)

SYMPTOM	CAUSE	REMEDY
2. Water in vehicle reservoirs.	A. Maximum air dryer inlet temperature is exceeded due to improper discharge line length.	A. Check for excessive carbon build up in compressor discharge line. Replace if required. Make certain that discharge line length is at least 6 ft. Increase discharge line length and/or diameter to reduce air dryer inlet temperature.
	B. Air system charged from outside air source (outside air not passing through air dryer).	B. If system must have outside air fill provision, outside air should pass through air dryer.
	C. Excessive air usage - Air dryer not compatible with vehicle air system requirement (Improper air dryer/vehicle application).	C. Refer to Bendix Advanced Troubleshooting Guide for Air Brake Compressors (BW1971) for proper application of the AD-IS® air dryer and reservoir system. An extended purge model (AD-ISEP) is available for many higher air usage vehicles, such as city buses and construction vehicles. If the vehicle is equipped with high air usage accessories such as trailer pump-off systems or central tire inflation, the air for these accessories must by-pass the dryer reservoir system.
	D. Desiccant requires replacement.	D. Replace desiccant cartridge assembly.
	E. Air by-passes desiccant cartridge assembly.	E. If vehicle uses Holset compressor, inspect feedback check valve for proper installation and operation.
	F. Air dryer not purging.	F. Refer to Symptom 6.
	G. Purge (air exhaust) time insufficient due to excessive system leakage.	G. Refer to Symptom 1.

TROUBLESHOOTING CHART (Continued)

SYMPTOM	CAUSE	REMEDY
3. Safety valve on air dryer "popping off" or exhausting air.	A. Defective AD-IS® air dryer and reservoir system delivery check valve.	A. Test to determine if air is passing through check valve. Repair or replace. Refer to Symptom 1, Remedy B.
	B. Safety valve setting too low (<150 p.s.i.)	B. Replace safety valve.
	C. System pressure too high (>135 p.s.i.)	C. Test with accurate gauge. Replace governor if necessary.
	D. Excessive pressure pulsations from compressor. (Typical single cylinder type).	D. Increase volume in discharge line. This can be accomplished by adding a 90 cubic inch (or larger) reservoir between the compressor and the AD-IS® air dryer and reservoir system.
4. Constant exhaust of air at air dryer purge valve exhaust or unable to build system pressure. (Charge mode.)	A. Air dryer purge valve leaking excessively.	A. With compressor loaded, apply soap solution on purge valve exhaust, to test for excessive leakage. Repair or replace purge valve as necessary. Refer to Technical Bulletin TCH-008-040.
	B. Purge valve frozen open - faulty heater and thermostat, wiring, blown fuse.	B. Refer to paragraph 5 of *Operation and Leakage Tests* for heater and thermostat test.
	C. Defective AD-IS® air dryer delivery check valve.	C. Refer to Symptom 1, Remedy B.
	D. Leaking Turbo Cut-Off valve.	D. Repair or replace purge valve assembly.
	E. Defective governor.	E. Check governor at both "cut-in" and "cut-out" position for (i) proper pressures and (ii) excessive leakage at fittings and exhaust.
	F. Leaking purge valve control piston quad-ring.	F. Repair or replace purge valve assembly.

TROUBLESHOOTING CHART (Continued)

SYMPTOM	CAUSE	REMEDY
5. Cannot build system air pressure.	A. Kinked or blocked (plugged) discharge line.	A. Check to determine if air passes through discharge line. Check for kinks, bends, excessive carbon deposits, or ice blockage.
	B. Excessive bends in discharge line (water collects and freezes).	B. Discharge line should be constantly sloping from compressor to air dryer with as few bends as possible.
	C. Pressure protection valve(s) in air dryer will not open.	C. Replace air dryer (pressure protection valves are not serviceable).
	D. Refer to Symptom 4.	D. Refer to Symptom 4, Remedy A.
	E. Refer to Symptom 7.	E. Refer to Symptom 7, Remedies A and B.
6. Air dryer does not purge or exhaust air.	A. Faulty air dryer purge valve.	A. After determining air reaches purge valve control port by installing a T-fitting with a pressure gauge into the governor unloader port, repair purge valve if necessary.
	B. See Causes B, E, and F for Symptom #4.	B. Refer to Symptom 4, Remedies B, E, and F. Also refer to Symptom 1, Remedy B.
7. Desiccant material being expelled from air dryer purge valve exhaust (may look like whitish liquid or paste or small beads.)	A. Faulty dryer cartridge.	A. Replace AD-IS® air dryer cartridge and/or AD-IS® air dryer.
	B. Excessive dryer vibration.	B. Check the AD-IS® air dryer mounting for looseness or damage. Repair mounting and replace cartridge.
8. Unsatisfactory desiccant life.	A. Excessive system leakage.	A. Refer to Symptom 1, Remedy A.
	B. Wrong vehicle application for AD-IS® air dryer.	B. Refer to Symptom 2, Remedy C.
	C. Compressor passing excessive oil.	C. Check for proper compressor installation; if symptoms persist, replace compressor. Refer to Bendix Advanced Troubleshooting Guide for Air Brake Compressor (BW1971).
9. "Pinging" noise excessive during compressor loaded cycle.	A. Single cylinder compressor with high pulse cycles.	A. A slight "pinging" sound may be heard during system build up when a single cylinder compressor is used. If this sound is deemed objectionable, it can be reduced substantially by increasing the discharge line volume. This can be accomplished by adding a 90 cubic inch (or larger) reservoir between the compressor and the AD-IS® air dryer and reservoir system.

TROUBLESHOOTING CHART (Continued)

SYMPTOM	CAUSE	REMEDY
10. The air dryer purge piston cycles rapidly in the compressor unloaded (non-compressing) mode.	A. Compressor fails to "unload".	A. Check air hose from governor to compressor for a missing, kinked or restricted line. Install or repair air hose. Repair or replace compressor unloader.

Bendix Service Data

SD-03-830

Bendix® E-8P™ & E-10P™ Dual Brake Valves

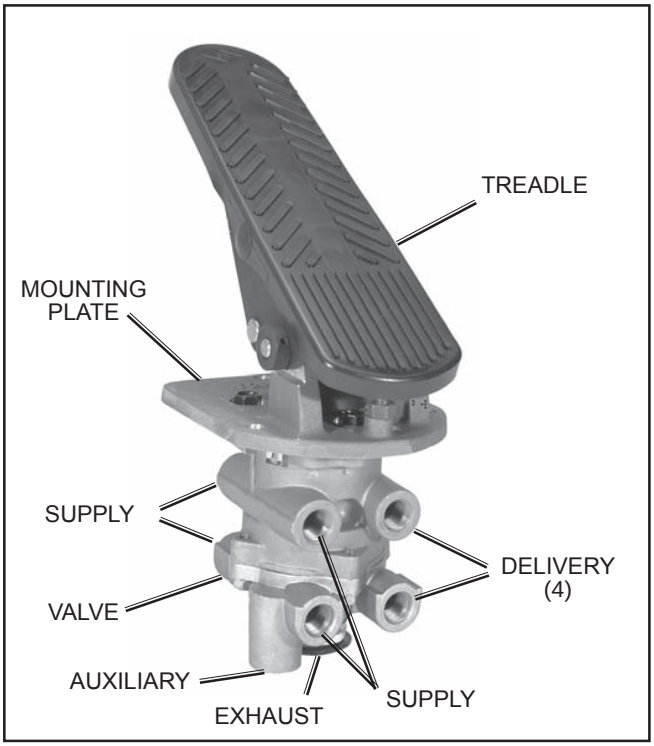


*FIGURE 1 - **E-8P™ DUAL BRAKE VALVE***

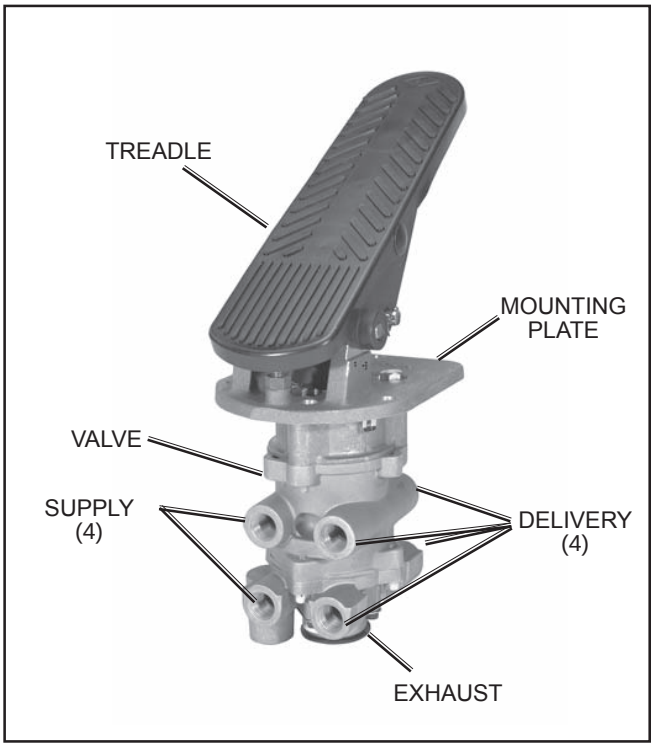


*FIGURE 2 - **E-10P™ DUAL BRAKE VALVE***

DESCRIPTION

Refer to Figures 4, 5 and 6 for item numbers referenced in parenthesis.

The Bendix® E-8P™ (Figure 1) and E-10P™ (Figure 2) dual brake valves are floor mounted, treadle operated type brake valves with two separate supply and delivery circuits for service (primary and secondary) braking, which provides the driver with a graduated control for applying and releasing the vehicle brakes.

The E-10P™ dual brake valve (Figure 2) is similar to the E-8P™ dual brake valve except that a metal coil spring (5) housed in an upper body assembly replaces the rubber spring (27) used in the E-8P™ valve. The use of a metal coil spring (and the upper body assembly) provides greater treadle travel and, therefore, provides the driver with a less sensitive “feel” when making a brake application. The E-10P™ dual brake valve is generally used on buses, where smooth brake applications contribute to passenger comfort.

The circuits in the E-8P™/E-10P™ dual brake valves are identified as follows: The No. 1 or primary circuit is that portion of the valve between the spring seat which contacts the plunger and the relay piston; the No. 2 or secondary circuit is that portion between the relay piston and the exhaust cavity.

The primary circuit of the valve is similar in operation to a standard single circuit air brake valve and under normal operating conditions the secondary circuit is similar in operation to a relay valve.

Both primary and secondary circuits of the brake valve use a common exhaust protected by an exhaust diaphragm.

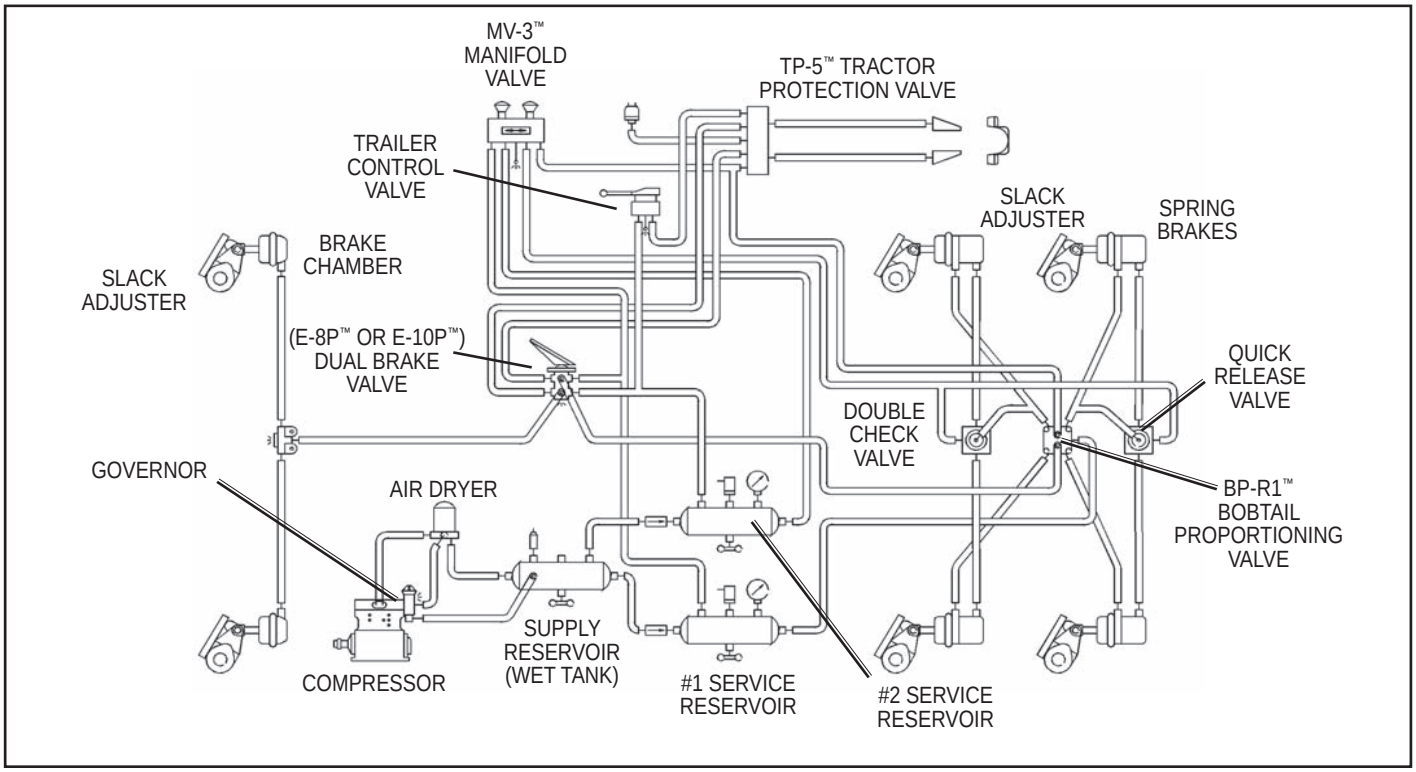


FIGURE 3 - ***TYPICAL PIPING SCHEMATIC***

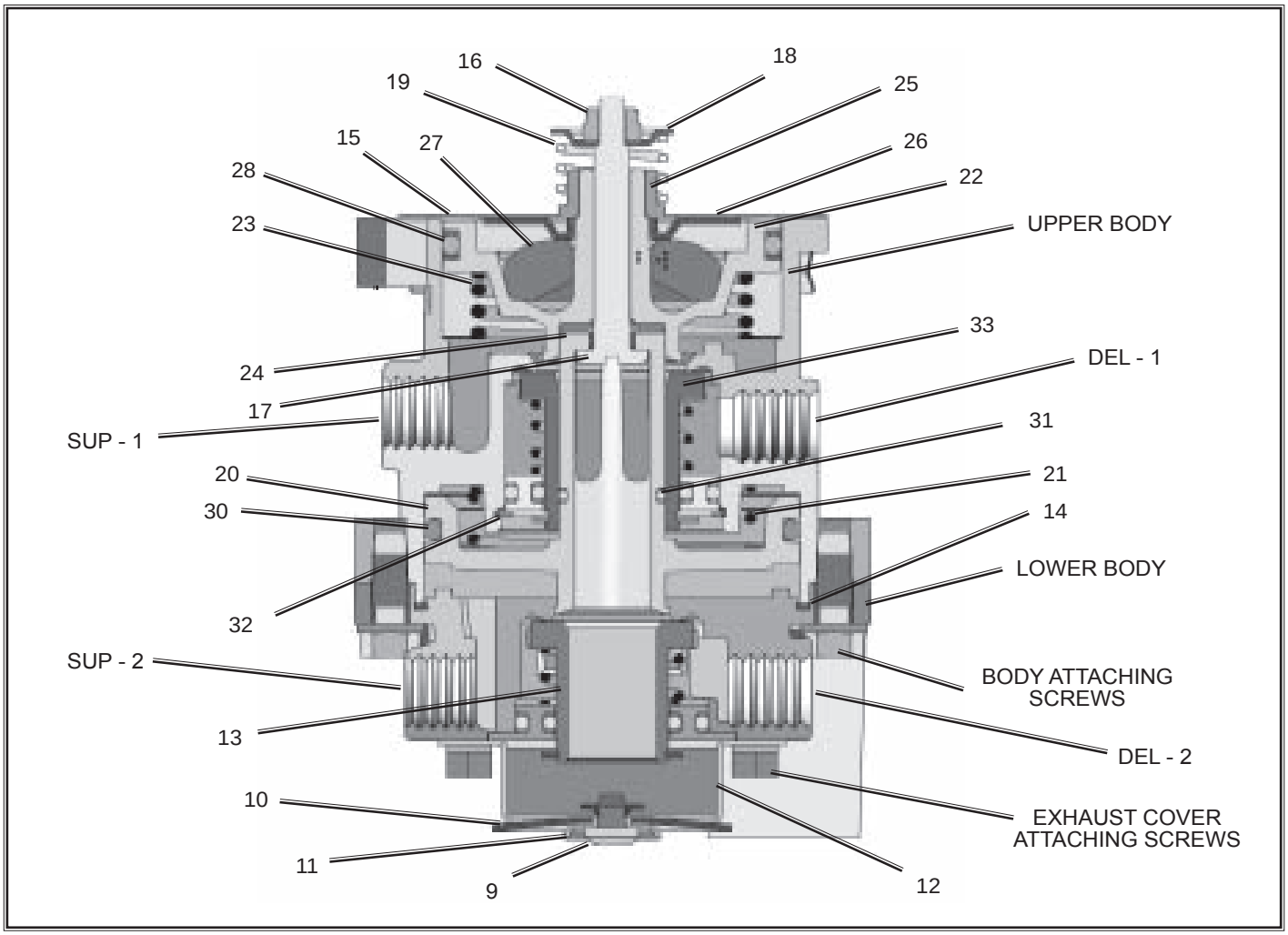


FIGURE 4 - ***E-8P™ DUAL BRAKE VALVE SECTIONAL VIEW***

2

OPERATION - Refer to Figure 3

APPLYING: NORMAL OPERATION - NO. 1 OR PRIMARY CIRCUIT PORTION

When the brake treadle is depressed, the plunger exerts force on the spring seat (26), graduating spring (23), and primary piston (22). The primary piston, which contains the exhaust valve seat, closes the primary exhaust valve. As the exhaust valve closes, the primary inlet valve is moved off its seat allowing primary air to flow out the No. 1 or primary delivery port.

APPLYING: NORMAL OPERATION - NO. 2 OR SECONDARY CIRCUIT

When the primary inlet valve (33) is moved off its seat, air is permitted to pass through the bleed passage and enters the relay piston cavity. The air pressure moves the relay piston (20), which contains the exhaust seat, and closes the secondary exhaust valve. As the secondary exhaust valve closes, the inlet valve (13) is moved off its seat allowing the secondary air to flow out the delivery of the same circuit. Because of the small volume of air required to move the relay piston (20), action of the secondary circuit of the valve is almost simultaneous with the primary circuit portion.

APPLYING: LOSS OF AIR IN THE NO. 2 OR SECONDARY CIRCUIT

Should air be lost in the No. 2 or secondary circuit, the No. 1 or primary circuit will continue to function as described above under *Normal Operation: No. 1 or Primary Circuit Portion*.

APPLYING: LOSS OF AIR IN THE NO. 1 OR PRIMARY CIRCUIT

Should air be lost in the primary circuit, the function will be as follows: As the brake treadle is depressed and no air pressure is present in the primary circuit supply and delivery ports, the primary piston (22) will mechanically move the relay piston (20), allowing the piston to close the secondary exhaust valve and open the secondary inlet valve and allow air to flow out the secondary delivery port.

BALANCED: NO. 1 OR PRIMARY CIRCUIT

When the primary delivery pressure acting on the primary piston (22) equals the mechanical force of the brake pedal application, the primary piston (22) will move and the primary inlet valve (33) will close, stopping further flow of air from the primary supply line through the valve. The exhaust valve remains closed preventing any escape of air through the exhaust port.

BALANCED: NO. 2 OR SECONDARY CIRCUIT

When the air pressure on the delivery side of the relay piston (20) approaches that being delivered on the primary side of the relay piston, the relay piston moves closing the secondary inlet valve and stopping further flow of air from the supply line through the valve. The exhaust remains closed as the secondary delivery pressure balances the primary delivery pressure.

When applications in the graduating range are made, a balanced position in the primary circuit is reached as the air pressure on the delivery side of the primary piston (22) equals the effort exerted by the driver's foot on the treadle. A balanced position in the secondary portion is reached when air pressure on the secondary side of the relay piston (20) closely approaches the air pressure on the primary side of the relay piston.

When the brake treadle is fully depressed, both the primary and secondary inlet valves remain open and full reservoir pressure is delivered to the actuators.

RELEASING: NO. 1 OR PRIMARY CIRCUIT

With the brake treadle released, mechanical force is removed from the spring seat (26), graduating spring (23), and primary piston (22). Air pressure and spring load moves the primary piston, opening the primary exhaust valve, allowing air pressure in the primary delivery line to exhaust out the exhaust port.

RELEASING: NO. 2 OR SECONDARY CIRCUIT

With the brake treadle released, air is exhausted from the primary circuit side of the relay piston (20). Air pressure and spring load move the relay piston, opening the secondary exhaust valve, allowing air pressure in the secondary delivery line to exhaust out the exhaust port.

PREVENTIVE MAINTENANCE

Important: Review the Bendix Warranty Policy before performing any intrusive maintenance procedures. A warranty may be voided if intrusive maintenance is performed during the warranty period.

No two vehicles operate under identical conditions, as a result, maintenance intervals may vary. Experience is a valuable guide in determining the best maintenance interval for air brake system components. At a minimum, the E-8P™ or E-10P™ valve should be inspected every 6 months or 1500 operating hours, whichever comes first, for proper operation. Should the E-8P™ or E-10P™ valve not meet the elements of the operational tests noted in this document, further investigation and service of the valve may be required.

Visually check for physical damage to the brake valve such as broken air lines and broken or missing parts.

Every 3 months, 25,000 miles, or 900 operating hours:

Clean any accumulated dirt, gravel, or foreign material away from the heel of the treadle, plunger boot, and mounting plate.

Lubricate the treadle roller, roller pin, and hinge pin, with Barium grease per BW-204-M (Bendix part 246671).

Check the rubber plunger boot for cracks, holes, or deterioration and replace if necessary. Also, check mounting plate and treadle for integrity.

Apply a thin layer of Barium grease, per BW-204-M (Bendix part 246671), between plunger and mounting plate – **do not over oil!**

SERVICE CHECKS

OPERATING CHECK

Check the delivery pressure of both primary and secondary circuits using accurate test gauges. Depress the treadle to several positions between the fully released and fully applied positions, and check the delivered pressure on the test gauges to see that it varies equally and proportionately with the movement of the brake pedal.

After a full application is released, the reading on the test gauges should fall off to zero promptly. It should be noted that the primary circuit delivery pressure will be about 2 PSI greater than the secondary circuit delivery pressure with both supply reservoirs at the same pressure. This is normal for this valve.

Important: A change in vehicle braking characteristics or a low pressure warning may indicate a malfunction in one or the other brake circuit, and although the vehicle air brake system may continue to function, the vehicle should not be operated until the necessary repairs have been made and both braking circuits, including the pneumatic and mechanical devices, are operating normally. Always check the vehicle brake system for proper operation after performing brake work and before returning the vehicle to service.

LEAKAGE CHECK

1. Make and hold a high pressure (80 psi) application.
2. Coat the exhaust port and body of the brake valve with a soap solution.
3. Leakage permitted is a 1" bubble in 3 seconds. If the brake valve does not function as described above or leakage is excessive, it is recommended that it be replaced with a new or remanufactured unit, or repaired with genuine Bendix parts available at authorized Bendix parts outlets.

Refer to figures 4, 5 and 6 for item numbers referenced in parenthesis.

REMOVAL

1. Chock the vehicle wheels or park the vehicle by mechanical means. (Block and hold vehicle by means other than air brakes.) Drain all air system reservoirs.
2. Identify and disconnect all supply and delivery lines at the brake valve.
3. Remove the brake valve and treadle assembly from the vehicle by removing the three cap screws on the outer bolt circle of the mounting plate. The basic brake valve alone can be removed by removing the three cap screws on the inner bolt circle.

DISASSEMBLY (Figures 4, 5 and 6)

1. If the entire brake valve and treadle assembly was removed from the vehicle, remove the three cap screws securing the treadle assembly to the basic brake valve.
2. Remove the screw (9) securing the exhaust diaphragm (10) and washer (11) to the exhaust cover (12).
3. Remove the four screws that secure the exhaust cover (12) to the lower body.
4. Remove the secondary inlet and exhaust valve assembly (13) from the lower body.
5. Remove the four hex head cap screws securing the lower body to the upper body and separate the body halves.
6. Remove the rubber seal ring (14) from the lower body.
7. **For E-8P™ valve only:** While applying thumb pressure to the primary piston (22), lift out and up on the three lock tabs of the primary piston retainer (15).
8. **For E-10P™ valve only:** While depressing spring seat (7), remove retaining ring (8). Remove spring seat (7) and coil spring (5).

   Caution: Before proceeding with the disassembly, refer to Figures 3 and 4 and note that the lock nut (16) and stem (17) are used to contain the primary piston return spring (**for E-8P™ valve:** 23, **for E-10P™ valve:** 6), stem spring (19), and the relay piston spring (21). The combined force of these springs is approximately 50 pounds and care must be taken when removing the lock nut as the spring forces will be released. It is recommended that the primary piston and relay piston be manually or mechanically contained while the nut and stem are being removed.
9. Using a 3/8” wrench, hold the lock nut (16) on the threaded end of the stem (17). Insert a screwdriver to restrain the stem, remove the lock nut (16), spring seat, (18) and stem spring (19).
10. **For E-10P™ valve only:** Remove adapter (1) and o-ring (4). Remove the primary piston (2) from adapter (1) and o-ring (34) from the primary piston (2).

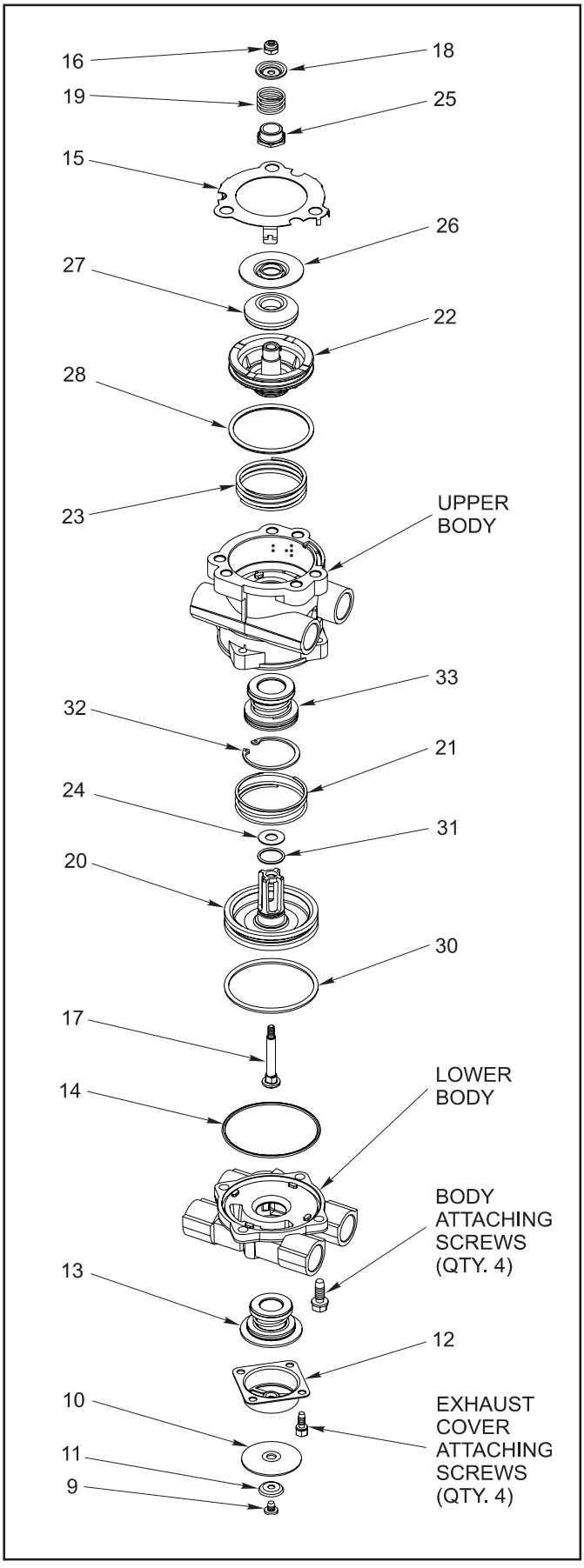


FIGURE 5 - ***E-8P™ DUAL BRAKE VALVE - EXPLODED VIEW***

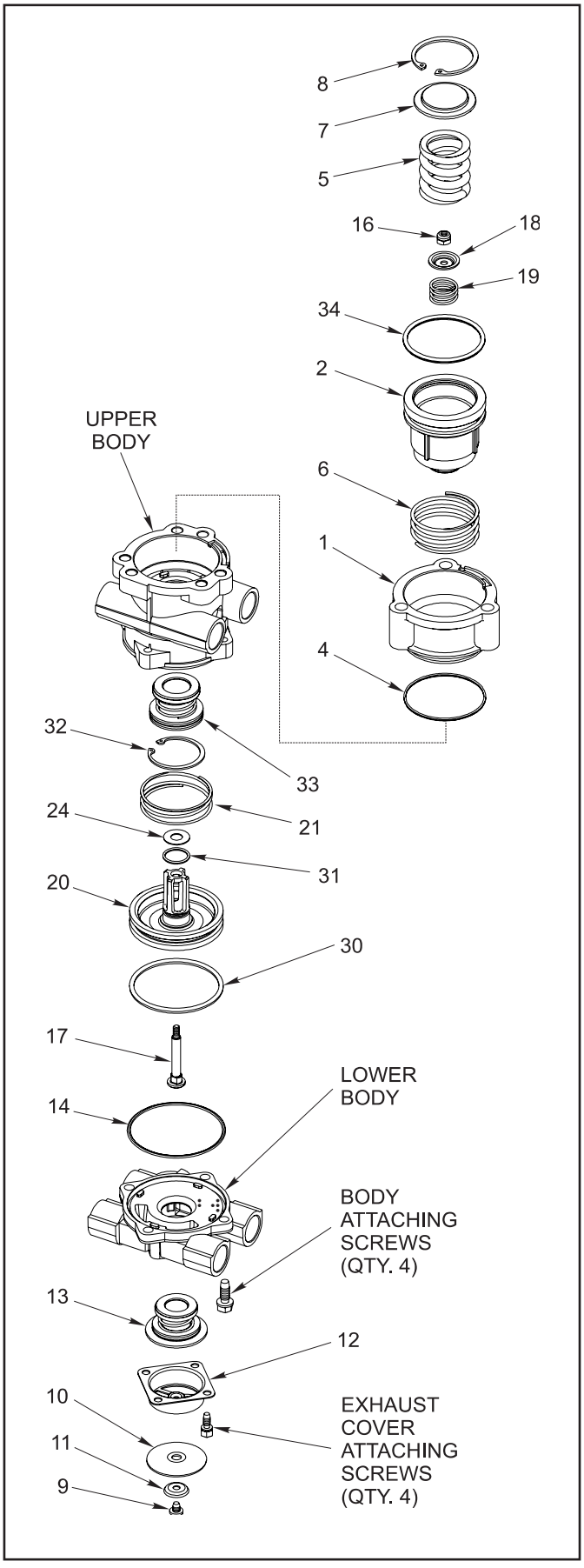


FIGURE 6 - ***E-10P™ DUAL BRAKE VALVE - EXPLODED VIEW***

11. Remove the relay piston (20), relay piston spring (21), primary piston (**E-8P™ valve:** 22, **E-10P™ valve:** 2) and primary piston return spring (**E-8P™ valve:** 23, **E-10P™ valve:** 6) from the upper body. Use care so as not to nick seats.
12. A small washer (24) will be found in the cavity of the lower side of the primary piston (**for E-8P™ valve***:* 22, **for E-10P™ valve:** 2).
13. For **E-8P™ valve only:** Disassemble the primary piston by rotating the spring seat nut (25) counterclockwise. Separate the spring seat nut, spring seat (26), and rubber spring (27) and remove the piston o-ring (28).
14. Remove the large and small o-rings (30 & 31) from the relay piston (20).
15. Remove the retaining ring (32) securing the primary inlet and exhaust valve assembly (33) in the upper body and remove the valve assembly.

CLEANING AND INSPECTION

1. Wash all metal parts in mineral spirits and dry.
2. Inspect all parts for excessive wear or deterioration.
3. Inspect the valve seats for nicks or burrs.
4. Check the springs for cracks or corrosion.
5. Replace all rubber parts and any part not found to be serviceable during inspection, use only genuine Bendix replacement parts.

ASSEMBLY

Prior to reassembling, lubricate all o-rings, o-ring grooves, piston bores, and metal to metal moving surfaces with Dow Corning 55 o-ring lubricant (Bendix piece number 291126).

Note: All torques specified in this manual are **assembly** torques and can be expected to fall off, after assembly is accomplished. **Do not retorque** after initial assembly torques fall.

1. Install the primary inlet and exhaust assembly (33) in the upper body and replace the retaining ring (32) to secure it. Be sure the retaining ring is seated completely in its groove.
2. Install the large and small o-rings (30 & 31) on the relay piston (20).
3. **For E-8P™ valve only:** Install o-ring (28) in the primary piston (22) o-ring groove.
4. **For E-8P™ valve only:** Install the rubber spring (do not lubricate) (27), concave side down in the primary piston (22) and place the spring seat (26), flat side up, over the rubber spring.
5. **For E-8P™ valve only:** Install the primary piston spring seat nut (25), with its hex closest to the spring seat, and rotate clockwise until the top surface of the spring seat is even with the top surface of the piston. Set aside.
6. Place relay piston spring (21) in concave portion of relay piston (20) and install relay piston through primary inlet/exhaust assembly (33) into under side of upper body.
7. **For E-10P™ valve only:** Install o-ring (4) on adapter (1) and install adapter on upper body. Install o-ring (34) on primary piston (2).
8. Place screwdriver, blade up, in vise. Insert stem (17) through the relay piston upper body sub assembly, slide this assembly over the blade of the secured screwdriver, engage the screwdriver blade in the slot in the head of the stem.
9. Place the washer (24) over the stem (17) and on top of the relay piston (20).
10. Install primary return spring (**E-8P™ valve:** 23, **E-10P™ valve:** 6) in upper body piston bore.
11. **For E-8P™ valve only:** Install the primary piston rubber spring sub assembly (steps 4 & 5) over the stem, into the upper body piston bore. **For E-10P™ valve:** Install primary piston sub-assembly (reference step 7).
12. Compress piston(s) (**For E-8P™ valve:** the relay piston (20), **for E-10P™ valve:** the primary and relay pistons (2 & 20)) and retaining ring into the upper body from either side and hold compressed, either manually or mechanically. **See the cautionary note under step 8 in the Disassembly section of this manual.**
13. Place the stem spring (19) (**E-8P™ valve:** place over the spring seat nut (25)), the spring seat (18) (concave side up) and lock nut (16) on the stem (17). Torque to 20 - 30 inch pounds.
14. **For E-8P™ valve only:** Install the primary piston retainer (15) over the piston, making certain all three lock tabs have engaged the outer lip of the body.
15. **For E-10P™ valve only:** Install coil spring (5), spring seat (7), and retaining ring (8) .
16. Replace the rubber seal ring (14) on the lower body.
17. Install the 4 hex head cap screws securing the lower body to the upper body. Torque to 30 - 60 inch pounds.
18. Install the secondary inlet and exhaust valve assembly (13) on the lower body.
19. Install the screws that secure the exhaust cover (12) to the lower body. Torque to 20 - 40 inch pounds.
20. Secure the screw (9) holding the exhaust diaphragm (10) and the diaphragm washer (11) to the exhaust cover (12). Torque to 5 - 10 inch pounds.
21. Install all air line fittings and plugs making certain thread sealant material does not enter valve.

VALVE INSTALLATION

1. Install the assembled brake valve on the vehicle.
2. Reconnect all air lines to the valve using the identification made during VALVE REMOVAL step 1.
3. After installing the brake valve assembly, perform the "OPERATION AND LEAKAGE CHECKS" before placing the vehicle in service.

GENERAL SAFETY GUIDELINES

WARNING! PLEASE READ AND FOLLOW THESE INSTRUCTIONS TO AVOID PERSONAL INJURY OR DEATH:

When working on or around a vehicle, the following general precautions should be observed at all times.

1. **Park the vehicle on a level surface, apply the parking brakes, and always block the wheels. Always wear safety glasses.**
2. **Stop the engine and remove ignition key when working under or around the vehicle. When working in the engine compartment, the engine should be shut off and the ignition key should be removed. Where circumstances require that the engine be in operation, EXTREME CAUTION should be used to prevent personal injury resulting from contact with moving, rotating, leaking, heated or electrically charged components.**
3. **Do not attempt to install, remove, disassemble or assemble a component until you have read and thoroughly understand the recommended procedures. Use only the proper tools and observe all precautions pertaining to use of those tools.**
4. **If the work is being performed on the vehicle's air brake system, or any auxiliary pressurized air systems, make certain to drain the air pressure from all reservoirs before beginning ANY work on the vehicle. If the vehicle is equipped with an AD-IS® air dryer system or a dryer reservoir module, be sure to drain the purge reservoir.**
5. **Following the vehicle manufacturer's recommended procedures, deactivate the electrical system in a manner that safely removes all electrical power from the vehicle.**
6. **Never exceed manufacturer's recommended pressures.**
7. **Never connect or disconnect a hose or line containing pressure; it may whip. Never remove a component or plug unless you are certain all system pressure has been depleted.**
8. **Use only genuine Bendix® replacement parts, components and kits. Replacement hardware, tubing, hose, fittings, etc. must be of equivalent size, type and strength as original equipment and be designed specifically for such applications and systems.**
9. **Components with stripped threads or damaged parts should be replaced rather than repaired. Do not attempt repairs requiring machining or welding unless specifically stated and approved by the vehicle and component manufacturer.**
10. **Prior to returning the vehicle to service, make certain all components and systems are restored to their proper operating condition.**
11. **For vehicles with Antilock Traction Control (ATC), the ATC function must be disabled (ATC indicator lamp should be ON) prior to performing any vehicle maintenance where one or more wheels on a drive axle are lifted off the ground and moving.**

Bendix

Service Data

SD-03-3611

Bendix® PP-1™, PP-2™, PP-5™, PP-8™, & RD-3™ Push-Pull Type Control Valves

FIGURE 1 - ***PUSH-PULL TYPE CONTROL VALVES***

DESCRIPTION

The PP valves are push-pull manually operable on-off air control valves with an exhaust function. Most are pressure sensitive, so that they will automatically move from the applied to the exhaust position as supply pressure is reduced to a certain minimum, depending on the spring installed. The exception to this is the PP-8™ valve and some PP-1™ valves which have no spring. The PP-8™ valve also has a larger diameter shaft for button mounting so that when installed on the same panel with other PP valves the buttons cannot be inadvertently mixed. The PP-8™ valve is normally used to operate tractor spring brakes independently from the trailer.

The PP-5™ valve is unique in having an auxiliary piston in the lower cover which, upon receiving a pneumatic signal of 18 psi or more, will cause the valve to move from the applied to the exhaust position from a 100 psi application.

The RD-3™ valve differs slightly in that it normally remains in the exhaust position and requires a constant manual force to hold it in the applied position.

The PP-2™ valve has an auxiliary port which may be plumbed into a service brake line to release the spring brakes if a service application is made, preventing compounding of forces on the foundation brakes.

PREVENTIVE MAINTENANCE

Important: Review the Bendix Warranty Policy before performing any intrusive maintenance procedures. A warranty may be voided if intrusive maintenance is performed during the warranty period.

No two vehicles operate under identical conditions, as a result, maintenance intervals may vary. Experience is a valuable guide in determining the best maintenance interval for air brake system components. At a minimum, the PP valves should be inspected every 6 months or 1500 operating hours, whichever comes first, for proper operation. Should the PP valves not meet the elements of the operational tests noted in this document, further investigation and service of the valve may be required.

	AUTOMATIC EXHAUST	MOMENTARY APPLY	PILOT TRIP FEATURE	NON-AUTOMATIC
PP-1	20,30,40 or 60 psi			
PP-2	40 psi			
PP-5	40 psi		18 psi	
RD-3		Must be held manually		
PP-8				Will remain in either position

REMOVAL

Block and/or hold the vehicle by a means other than air brakes and drain all reservoirs.

1. Drive the button roll-pin out with a punch and remove the button.
2. Mark each air supply line and its port for easy reinstallation, then disconnect them. Remove the valve from the panel by removing the panel mounting nut.

INSTALLING

1. Install valve in panel, securing with the panel mounting nut.
2. Reconnect the air lines using marks made during removal as a guide.
3. Install the operating button. Secure the operating button by installing the button roll pin.

DISASSEMBLY: PP-1™, PP-8™ AND RD-3™ VALVES

1. Remove the two cap screws (3) which retain the lower cover and remove cover. Remove the sealing ring (4).
2. Insert a small punch through the roll pin hole in the stem and remove the lock nut (5).
3. Remove inlet-exhaust valve (6) and plunger (7) and spring (8) (if any).
4. Remove o-ring (9) from plunger.

DISASSEMBLY: PP-5™ VALVE

1. Perform same operations as for PP-1™ valve.
2. Remove inlet seal (10) in Figure 4 from lower cover. Remove the ring diaphragm (4) from the inlet seat.
3. Remove piston (11) Figure 4 and o-ring (2).

DISASSEMBLY: PP-2™ VALVE

1. Insert a small punch through the roll pin hole in the plunger and remove the lock nut (1) from the plunger.
2. Withdraw the plunger and remove the spring (9) and o-ring (8).
3. Remove the two machine screws (2) and remove the lower cover (3).
4. Remove the inlet-exhaust valve (4), and piston (5).
5. Remove o-rings (6 & 7) from piston.

OPERATING AND LEAKAGE TESTS

PP-1™, PP-8™, RD-3™ VALVE

1. An accurate test gauge should be tee'd into the supply line and a means of controlling the supply pressure provided. Apply a 120 psi air source to the supply port. A small volume reservoir (e.g. 90 cu. in.) with a gauge should be connected to the delivery port.
2. With 120 psi supply pressure, and the button pulled out (exhaust position), leakage at the exhaust port should not exceed a 1" bubble in 5 seconds; at the plunger stem a 1" bubble in 5 seconds. There should be no leakage between upper and lower body.
3. Push the button in (applied position). Leakage at the exhaust port should not exceed a 1" bubble in 3 seconds; at the plunger a 1" bubble in 3 seconds. (The RD-3™ valve will have to be manually held in this position.)
4. Reduce the supply pressure. At a pressure from 60 to 20 psi depending on the spring installed the button should pop out automatically, exhausting the delivery volume. (This does not apply to the RD-3™, PP-8™ or some PP-1™ valve's).

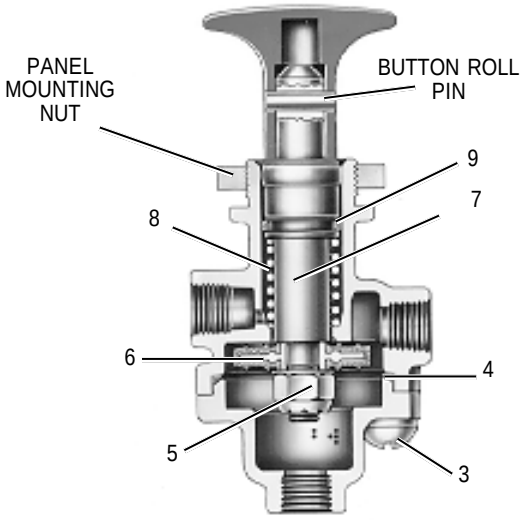
PP-5™ VALVE

1. Proceed as for PP-1™ valve through Step 3.
2. Connect a modulated source of air pressure to the pilot air inlet. With the button pushed in (applied position) with 125 psi supply pressure and a gradually increasing pressure applied at the pilot air port the valve should move to the release position with a pilot pressure of not more than 18 psi. Leakage in this mode should not exceed a 1" bubble in 3 seconds at the exhaust port and a 1" bubble in 5 seconds at the plunger stem.

PP-2™ VALVE

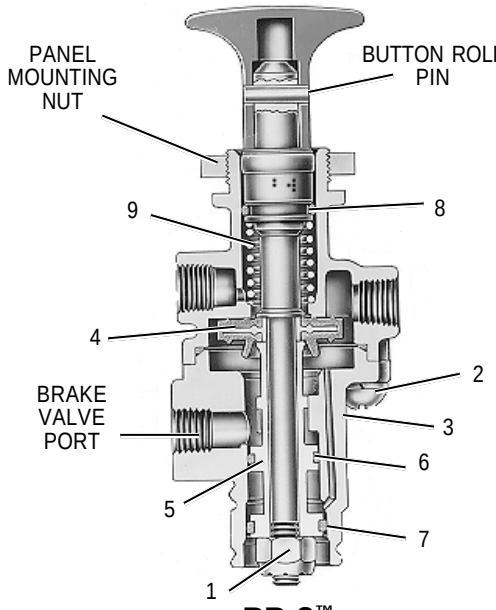
1. Proceed as for PP-1™ valve through Step 1.
2. With the button pulled out (exhaust position), leakage at the brake valve port or at the plunger stem should not exceed a 1" bubble in 5 seconds.
3. Push the button in. Supply pressure should be present in the delivery volume. Leakage at the exhaust port or around the plunger stem should not exceed a 1" bubble in 5 seconds.
4. Pull the button out and apply supply pressure at the brake valve port. Supply pressure should be present in the delivery volume and leakage at the exhaust port should not exceed a 1" bubble in 5 seconds.

Note: If any of the above push-pull valves do not function as described or if leakage is excessive, it is recommended they be returned to our nearest authorized distributor for a factory rebuilt or new valve.



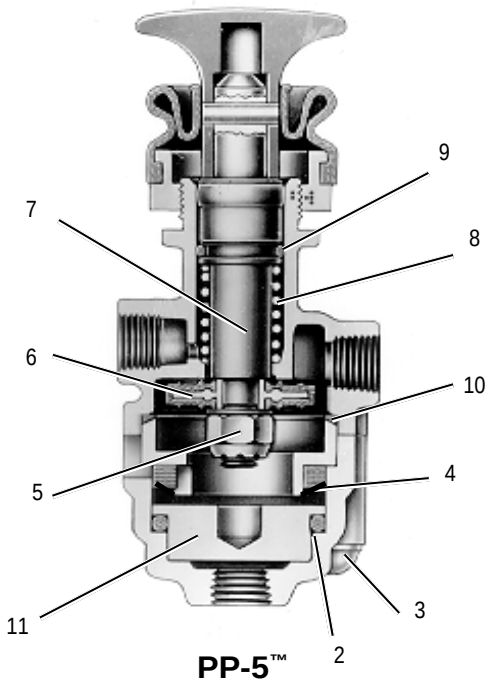
PP-1™ VALVE

FIGURE 2



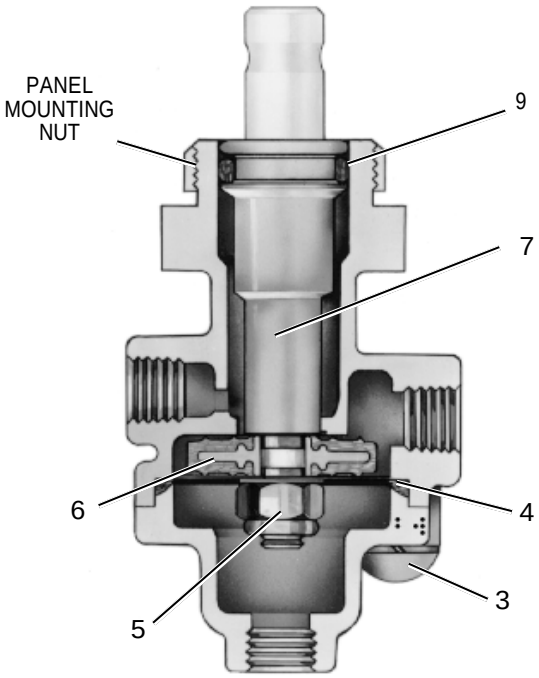
PP-2™ VALVE

FIGURE 3



PP-5™ VALVE

FIGURE 4



PP-8™ VALVE

FIGURE 5

GENERAL SAFETY GUIDELINES

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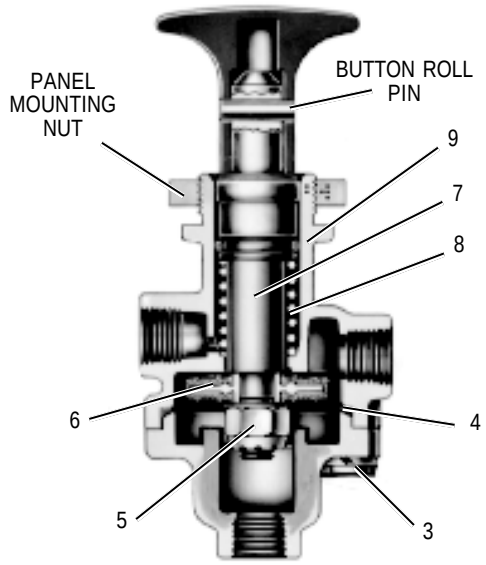
1. **Park the vehicle on a level surface, apply the parking brakes, and always block the wheels. Always wear safety glasses.**
2. **Stop the engine and remove ignition key when working under or around the vehicle. When working in the engine compartment, the engine should be shut off and the ignition key should be removed. Where circumstances require that the engine be in operation, EXTREME CAUTION should be used to prevent personal injury resulting from contact with moving, rotating, leaking, heated or electrically charged components.**
3. **Do not attempt to install, remove, disassemble or assemble a component until you have read and thoroughly understand the recommended procedures. Use only the proper tools and observe all precautions pertaining to use of those tools.**
4. **If the work is being performed on the vehicle's air brake system, or any auxiliary pressurized air systems, make certain to drain the air pressure from all reservoirs before beginning ANY work on the vehicle. If the vehicle is equipped with an AD-IS® air dryer system or a dryer reservoir module, be sure to drain the purge reservoir.**
5. **Following the vehicle manufacturer's recommended procedures, deactivate the electrical system in a manner that safely removes all electrical power from the vehicle.**
6. **Never exceed manufacturer's recommended pressures.**
7. **Never connect or disconnect a hose or line containing pressure; it may whip. Never remove a component or plug unless you are certain all system pressure has been depleted.**



RD-3™
VALVE

FIGURE 6

8. **Use only genuine Bendix® replacement parts, components and kits. Replacement hardware, tubing, hose, fittings, etc. must be of equivalent size, type and strength as original equipment and be designed specifically for such applications and systems.**
9. **Components with stripped threads or damaged parts should be replaced rather than repaired. Do not attempt repairs requiring machining or welding unless specifically stated and approved by the vehicle and component manufacturer.**
10. **Prior to returning the vehicle to service, make certain all components and systems are restored to their proper operating condition.**
11. **For vehicles with Antilock Traction Control (ATC), the ATC function must be disabled (ATC indicator lamp should be ON) prior to performing any vehicle maintenance where one or more wheels on a drive axle are lifted off the ground and moving.on a drive axle are lifted off the ground and moving.**

Bendix

Service Data

SD-13-4870

Bendix® M-32™ and M-32QR™ AntiLock Modulators

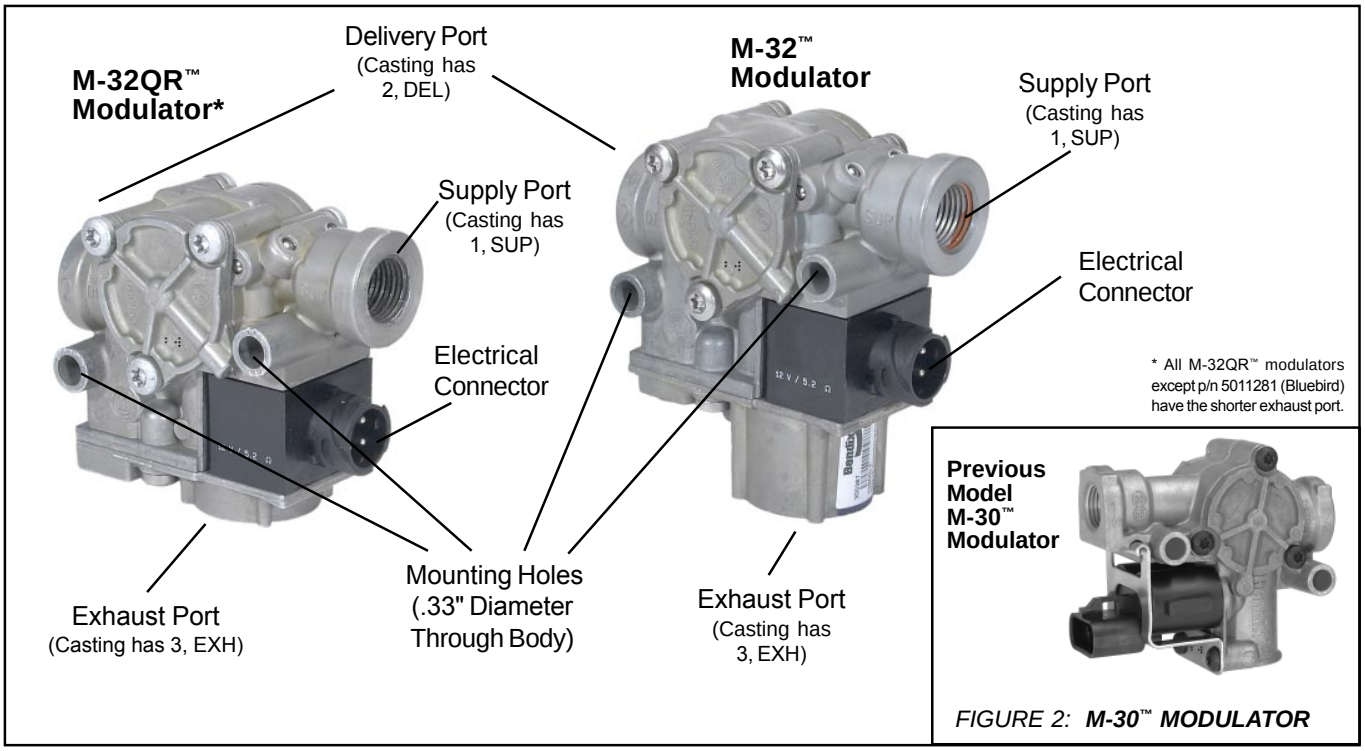


FIGURE 2: ***M-30™ MODULATOR***

FIGURE 1: ***M-32™ AND M-32QR™ MODULATORS***

DESCRIPTION

The M-32™ and M-32QR™ (quick release) antilock system modulators (Figure 1) are high capacity, on/off air valves that incorporate a pair of electrical solenoids for control. The solenoids provide the electro-pneumatic interface between the antilock controller electronics and the air brake system. The modulator is used to control the braking function on individual or dual service actuators during antilock activity.

The M-32QR™ modulator is the direct replacement for the M-30™ (Figure 2) modulator in all applications. The M-32QR™ modulator includes a bias valve to provide an internal quick release function. In applications using an M-32™ modulator, an external quick release valve may be required, depending on the system design (see Figure 3 for typical system schematics). When used to control both service chambers on an axle or two chambers on the same side of a tandem axle, the modulator is sometimes mounted ahead of a quick release valve, which provides quick exhaust of service applications during normal braking. In the case of individual wheel control applications, the modulator is always the last control valve through which air passes on its way to the service brake actuator.

The modulator consists of a die cast aluminum body and a solenoid assembly which contains one normally open solenoid, one normally closed solenoid, and an inlet and exhaust diaphragm valve. A three pin, weather resistant electrical connector is an integral part of the modulator solenoid assembly and serves to carry control commands from the antilock controller to the modulator. Two mounting holes are provided for frame or cross member mounting of the valve.

The supply, delivery and exhaust ports on the M-32™ modulator are identified with a cast, embossed numeral for positive identification.

Identification	Air Line Connection
1, SUP	Supply (incoming air from foot, relay or quick release valve)
2, DEL	Delivery (air delivery to service actuators)
3, EXH	Exhaust

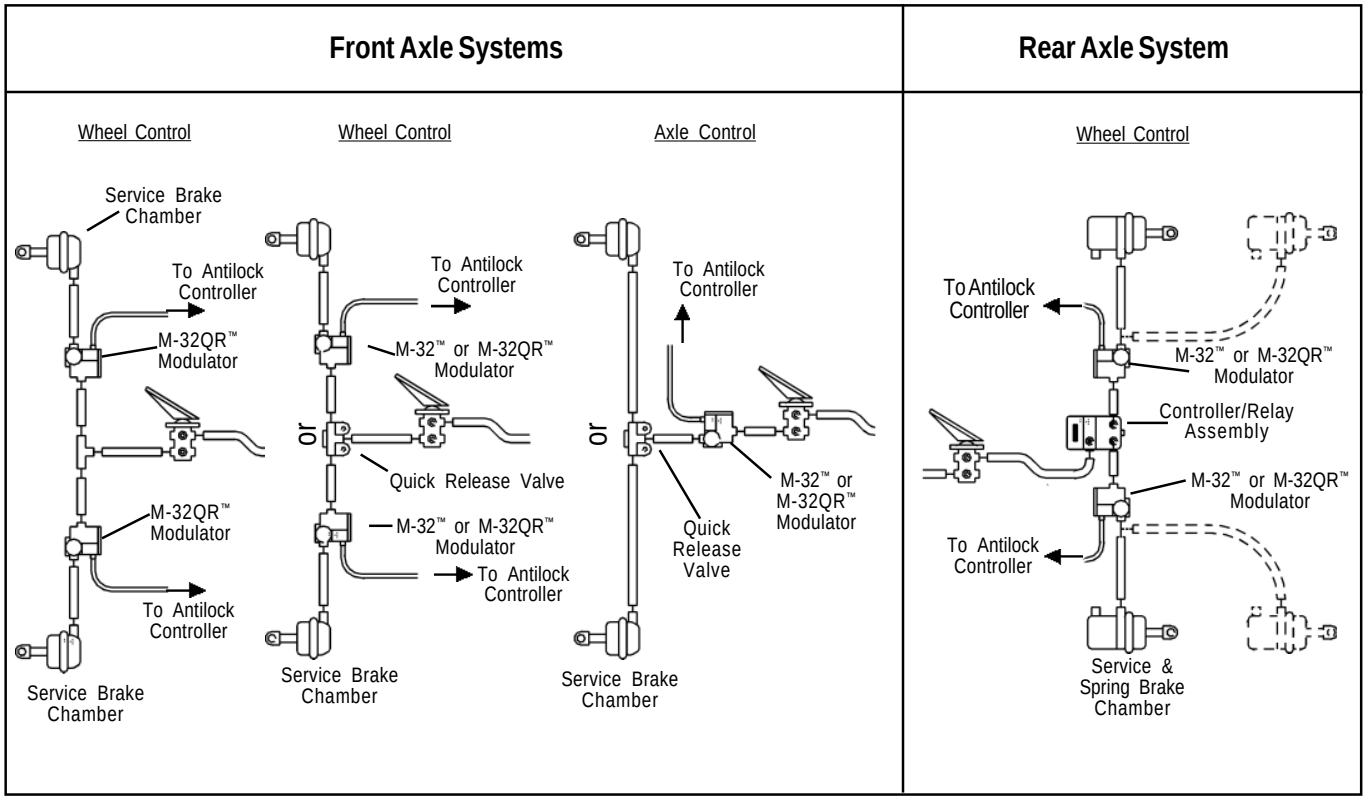


FIGURE 3: ***TYPICAL WHEEL AND AXLE CONTROL SYSTEMS***
NOTE: *use of a quick release valve is not typically required with the M-32QR™ modulator. Refer to vehicle specifications for recommended configuration.*

FUNCTIONAL CHECK

A wiring harness connects the vehicle modulators to the controller. The ABS controller is able to simultaneously and independently control the individual modulators. When vehicle power is supplied to the ABS ECU, a modulator "chuff" test is performed. When the brake pedal is depressed and the ignition turned on, the modulator "chuff" test can be heard. This test will verify if the modulator is functioning pneumatically correct. The modulators will exhaust air in the sequence of right front, left front, right rear, left rear. If they do not follow this sequence, proceed with modulator troubleshooting.

OPERATION

NON-ANTILOCK BRAKE APPLICATION *(Figure 4)*

During normal, non antilock braking, both solenoids are de-energized (no electrical power). Brake application air enters the Supply port of the modulator and flows to the exhaust diaphragm. Air pressure, along with spring force, seats the exhaust diaphragm on the exhaust passage, thus preventing the escape of service air. Simultaneously, application air flows to the supply diaphragm and forces it away from its seat. Air flows past the open supply port and out the modulator delivery port to the service brake chambers.

NON-ANTILOCK HOLD *(Figure 5)*

When the desired air pressure is attained in the service brake chambers, the brake system is in the Holding position. In the Holding position, both solenoids in the modulator remain de-energized and the balance of the internal components remain in the same position as they assumed during application.

NON-ANTILOCK EXHAUST

The manner in which air exhausts through the modulator differs depends upon how rapidly the brake application is released by the driver.

Normal Exhaust *(Figure 6)* - During a normal, relatively “slow” brake release, air moves back through the modulator in the reverse direction as it flowed during application. The internal components of the modulator will remain in the same position as they assumed during application until air pressure decreases to approximately one half psi, at which time the supply diaphragm will seat on the supply passage. A relatively small amount of air will generally be expelled from the modulator exhaust port during “slow” brake release.

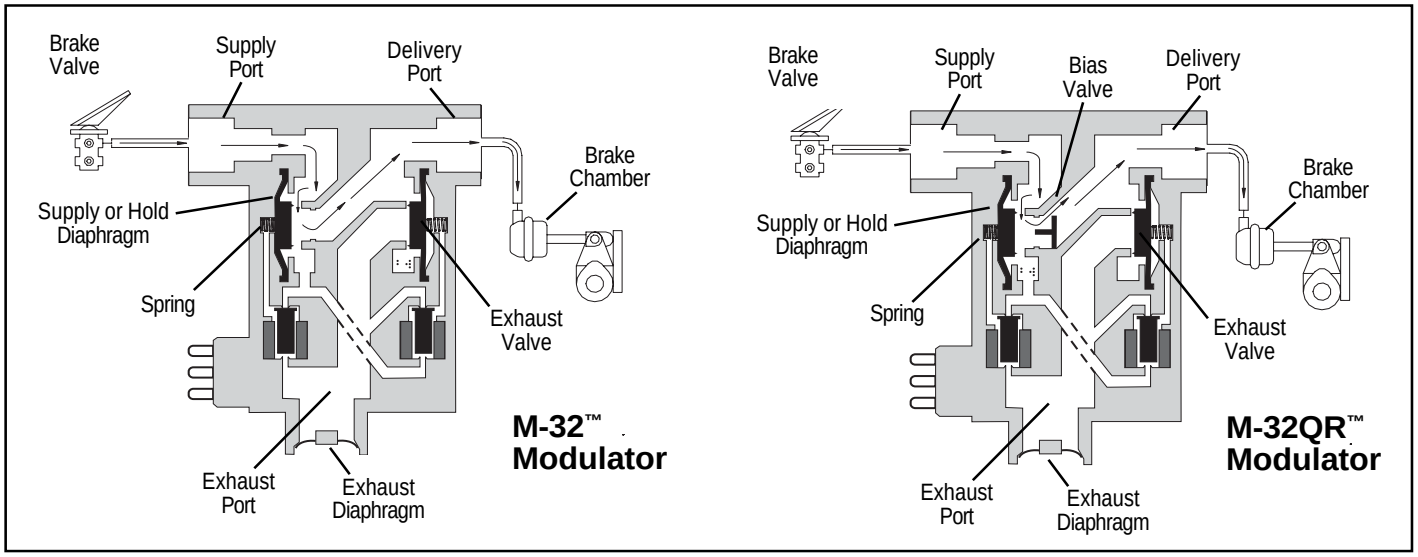


FIGURE 4: ***M-32™ AND M-32QR™ MODULATORS NON-ANTILOCK APPLICATION OF SERVICE BRAKES***

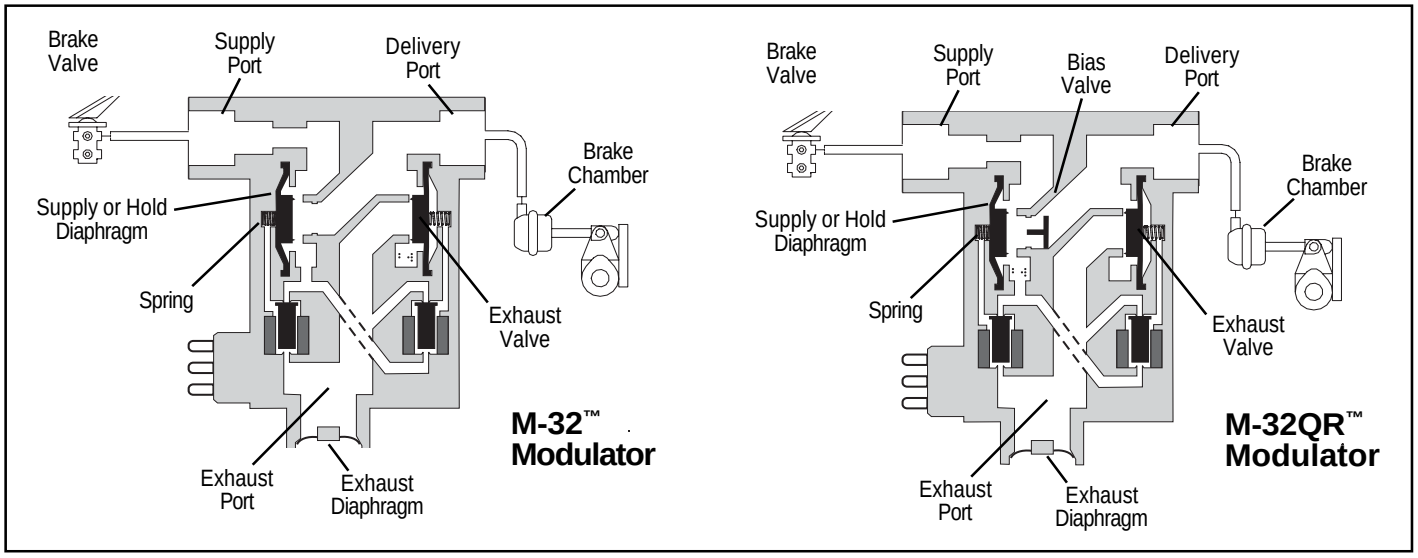


FIGURE 5: ***M-32™ AND M-32QR™ MODULATORS NON-ANTILOCK BRAKE APPLICATION HELD POSITION***

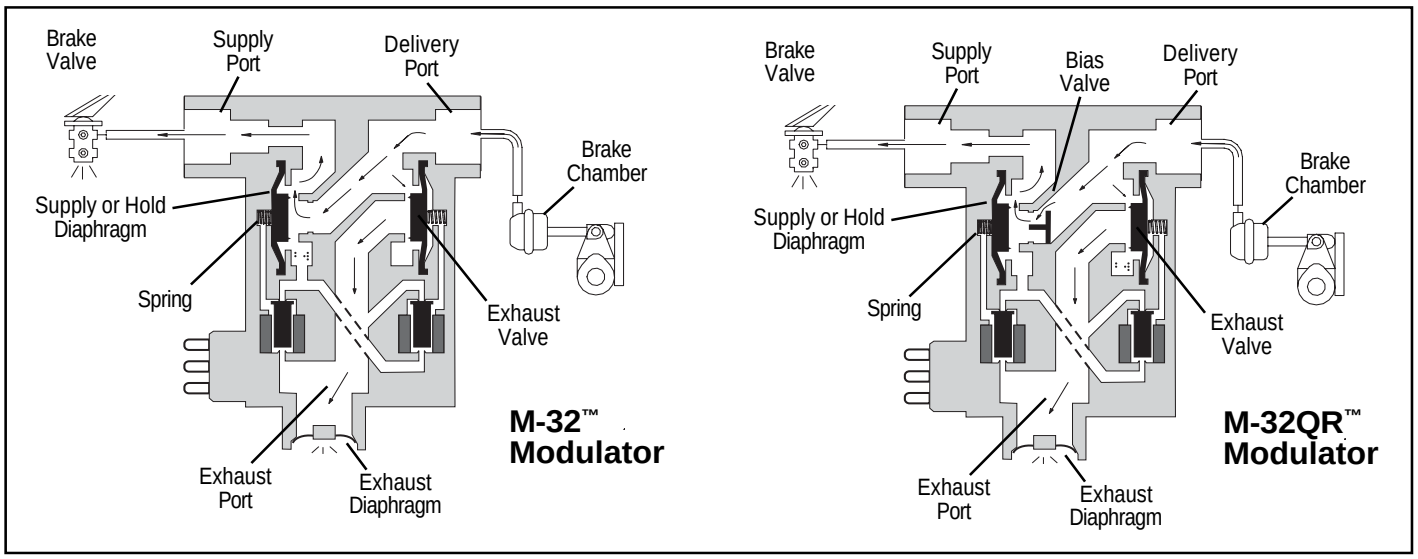


FIGURE 6: ***M-32™ and M-32QR™ MODULATORS "SLOW" NON-ANTILOCK EXHAUST OF SERVICE BRAKES***

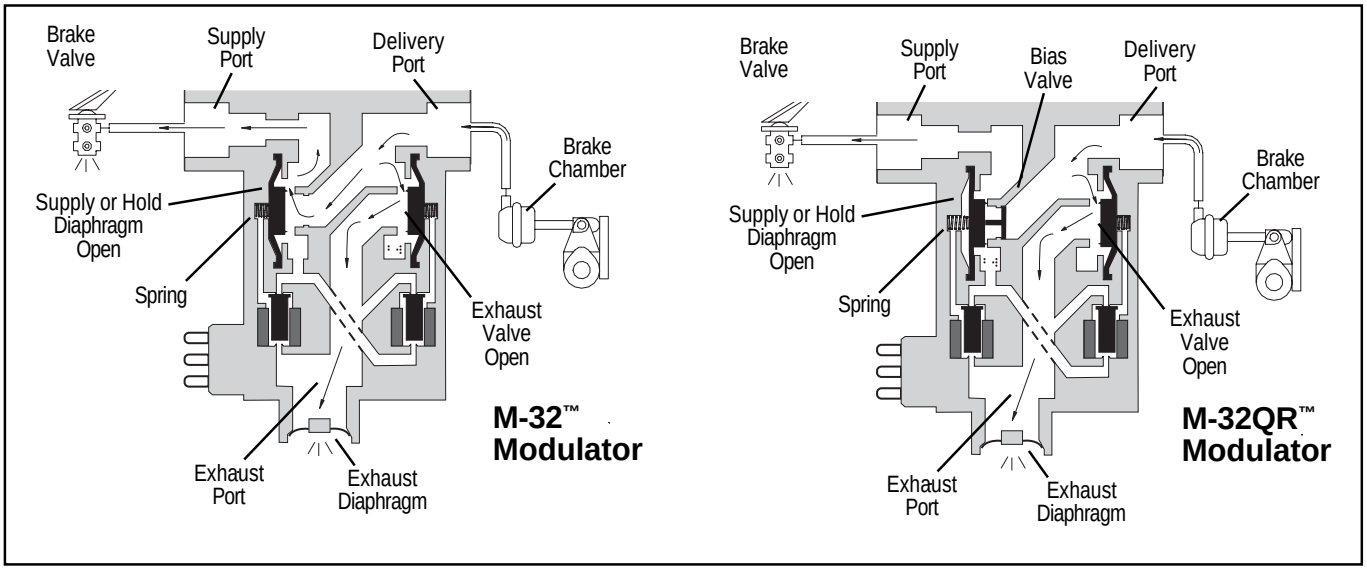


FIGURE 7: ***M-32™ AND M-32QR™ MODULATORS RAPID NON-ANTILOCK EXHAUST OF SERVICE BRAKES***

Rapid Exhaust *(Figure 7)* - The Rapid Exhaust operation described in the following text occurs when the modulator is controlling service chamber(s). During a rapid brake release the quick release modulator will exhaust air differently to a "slow" brake release.

An example of this would be the case if the driver made a severe brake application then lifted his foot from the foot valve. During a rapid brake release, the air previously delivered to the brake chamber is vented through the M-32™ modulators as follows:

For the M-32QR™ Modulator: The bias valve moves to its closed position, closing the air return route to the brake valve's exhaust. Air pressure against the exhaust valve within the M-32™ modulator overcomes the spring force and allows air to exhaust through the M-32QR™ modulator exhaust port. Residual air pressure between the bias valve and the brake pedal flows back to the brake valve exhaust.

For the M-32™ Modulator: As in the "slow" brake release, air pressure travels back to the brake valve's exhaust, but also the air pressure against the exhaust valve within the M-32™ modulator overcomes the spring force and allows air to exhaust through the M-32™ modulator exhaust port.

ANTILOCK OPERATION

GENERAL

If a service brake application is made and the antilock system detects an impending wheel lockup, the antilock controller will make a controlled brake application using the modulator.

In order to control the brake application, the coils of the two solenoid valves contained in the modulator are energized or de-energized in a preprogrammed sequence by the antilock controller. When a solenoid coil is energized, and depending whether the exhaust or hold solenoid is energized, it either opens or closes, thereby causing the exhaust or reapplication of air pressure to the brake actuator. The solenoids in the modulator are controlled independently by the antilock controller (ECU).

An experienced driver (of a vehicle without ABS) who encounters wheel lock-up may sometimes "pump the brakes" in order to attempt to prevent wheel lock-up and maintain vehicle control. In the case of an ABS braking system, the driver does not need to "pump the brakes" since the antilock controller is able to apply and release the brakes using the modulators, with far greater speed and accuracy. Depending on the number of modulators used, some systems are able to apply braking power to wheels independently (see page 2).

ANTILOCK EXHAUST *(Figure 8)*

When wheel lock is detected or imminent, the antilock controller energizes the supply and exhaust solenoids in the modulator.

Energizing the supply solenoid allows application air to flow to the control side of the supply diaphragm. Air pressure acting on the supply diaphragm, along with the spring force, enables the diaphragm to prevent further delivery of air to the brake chamber.

Energizing the exhaust solenoid shuts off the air normally applied to the control side of the exhaust diaphragm to keep it closed. Air pressure acting on the exhaust diaphragm, overcomes the spring force, and allows air to exhaust through the exhaust port.

ANTILOCK HOLD MODE *(Figure 9)*

The antilock controller will place the modulator in the Hold position when it senses that the correct wheel speed (braking force) has been attained. The antilock controller will also

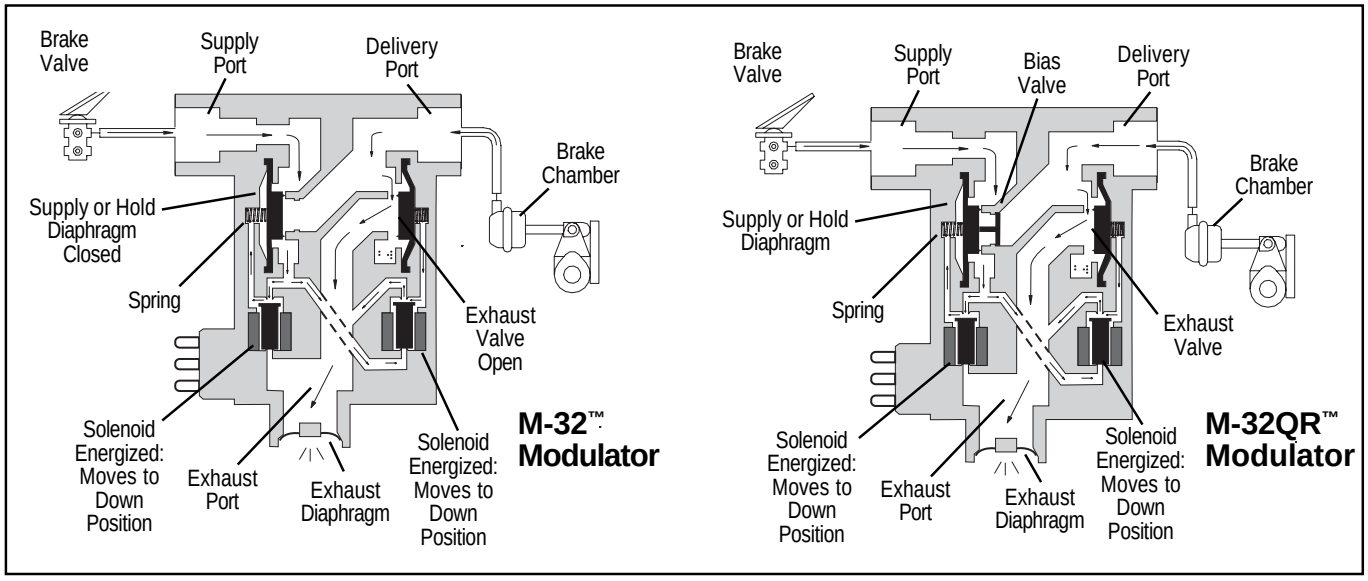


*FIGURE 8: **M-32™ MODULATOR ANTILOCK EXHAUST OF BRAKES***

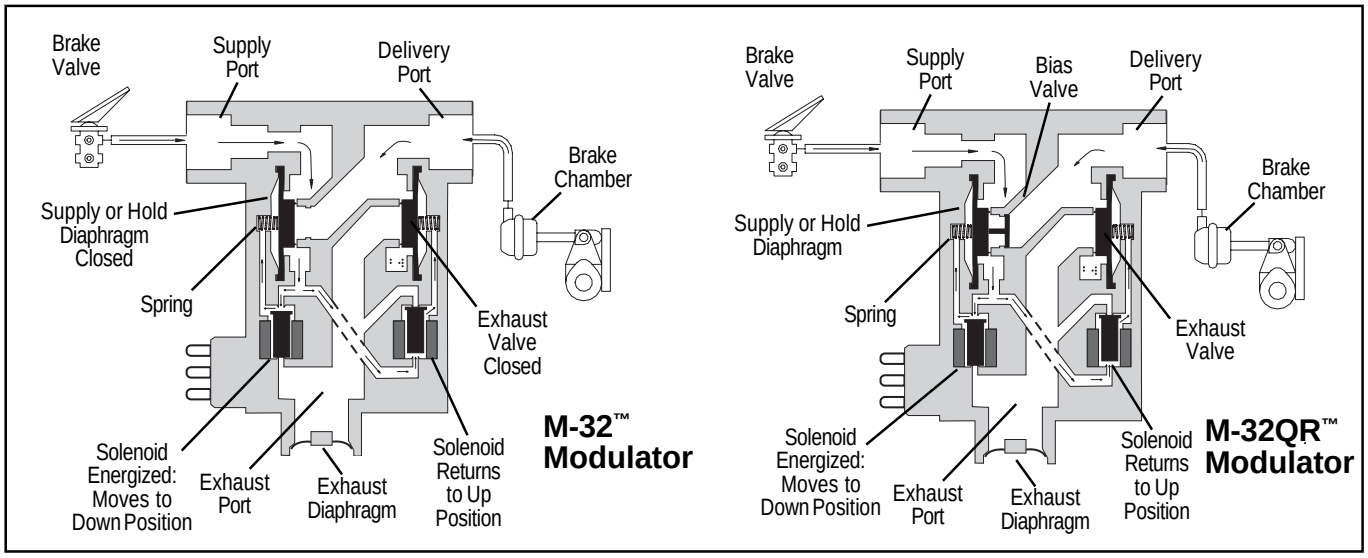


*FIGURE 9: **M-32™ AND M-32QR™ MODULATORS ANTILOCK APPLICATION HELD POSITION***

place the modulator in the hold position, prior to entering the reapply mode, when it detects recovery from a locked wheel condition. In this mode of operation, the modulator supply/hold solenoid remains energized while the exhaust solenoid returns to its normal position. The exhaust solenoid allows application air to flow to the control side of the exhaust diaphragm, which then seals the exhaust passage. With the exhaust diaphragm seated, further exhaust of brake chamber air pressure is prevented. Because the supply solenoid remains energized, the supply diaphragm remains seated, thus preventing application air from flowing to the delivery port and out to the brake chamber. The modulator can enter both the antilock exhaust or reapply mode from the antilock hold mode depending on the needs of the antilock controller.

ANTILOCK "REAPPLY" MODE

If the antilock controller senses that wheel speed has increased sufficiently enough to allow re-application of braking pressure, without further wheel lock-up, it de-energizes the supply solenoid. With both solenoids de-energized, the modulator re-applies air to the brakes in the same manner it did during a non-antilock event.

PREVENTIVE MAINTENANCE

GENERAL

Perform the tests and inspections presented at the prescribed intervals. If the modulator fails to function as described, or leakage is excessive, it should be replaced with a new Bendix unit, available at any authorized parts outlet.

EVERY MONTH, 10,000 MILES OR 350 OPERATING HOURS

1. Remove any accumulated contaminates and visually inspect the exterior for excessive corrosion and physical damage.
2. Inspect all air lines and wire harnesses connected to the modulator for signs of wear or physical damage. Replace as necessary.
3. Test air line fittings for leakage and tighten or replace as necessary.
4. Perform the ROUTINE OPERATION AND LEAKAGE TESTING described in this manual.

OPERATION & LEAKAGE TESTS

LEAKAGE TEST

1. Park the vehicle on a level surface and block or chock the wheels. Release the parking brakes and build the air system to full pressure.
2. Turn the engine OFF and make 4 or 5 brake applications and note that the service brakes apply and release promptly.
3. Build system pressure to governor cut-out and turn the engine OFF.
4. After determining the pressure loss with the brakes released (2 PSI/minute allowed), make and hold a full service brake application. Allow the pressure to stabilize for one minute.
5. Begin timing pressure loss for two minutes while watching the dash gauges for a pressure drop. The leakage rate for the service reservoirs should not exceed 3 PSI/minute.
6. If either circuit exceeds the recommended two PSI/minute, apply soap solution to the exhaust port of the modulator and any other components in the respective circuit.
7. The leakage at the exhaust port of most Bendix components, including M-32™ modulators, should not exceed a one-inch bubble in three seconds. If leakage at the modulator is determined to exceed the maximum limits, replace the modulator.

OPERATION TEST

To properly test the function of the modulator will require two (2) service technicians.

1. Park the vehicle on a level surface and block or chock the wheels. Release the parking brakes and build the air system to governor cut out.
2. Turn the engine ignition key to the OFF position then make and hold a full brake application.
3. With the brake application held and one (1) service technician posted at one (1) of the modulators, turn the vehicle ignition key to the ON position. ONE OR TWO SHORT bursts of air pressure should be noted at the modulator exhaust. Repeat the test for each modulator on the vehicle. If at least a single burst of exhaust is not noted or the exhaust of air is prolonged and not short, sharp and well defined, perform the Electrical Tests.

ELECTRICAL TESTS

1. Before testing the solenoid assembly of a suspect modulator, its location on the vehicle should be confirmed using the Trouble Shooting or Start Up procedure for the specific antilock controller in use. (See the Service Data Sheet for the antilock controller for this procedure.)
2. Proceed to the modulator in question and inspect its wiring connector. Disconnect the connector and test the resistance between the pins ON THE MODULATOR. Refer to Figures 10 and 11.

A. HOLD TO SOURCE **(41-42)**: Read 4.9 to 5.5 Ohms.

B. EXHAUST TO SOURCE **(43-41)**: Read 4.9 to 5.5 Ohms.

C. EXHAUST TO HOLD **(43-42)**: Read 9.8 to 11.0 Ohms.

D. Individually test the resistance of each pin to vehicle ground and note there is NO CONTINUITY.

If the resistance readings are as shown, the wire harness leading to the modulator may require repair or replacement. Before attempting repair or replacement of the wire harness, refer to the test procedures specified for the antilock controller in use for possible further testing that may be required to substantiate the wire harness problem. If the resistance values are NOT AS STATED, replace the modulator.

WARNING! PLEASE READ AND FOLLOW THESE INSTRUCTIONS TO AVOID PERSONAL INJURY OR DEATH:

When working on or around a vehicle, the following general precautions should be observed at all times.

1. **Park the vehicle on a level surface, apply the parking brakes, and always block the wheels. Always wear safety glasses.**

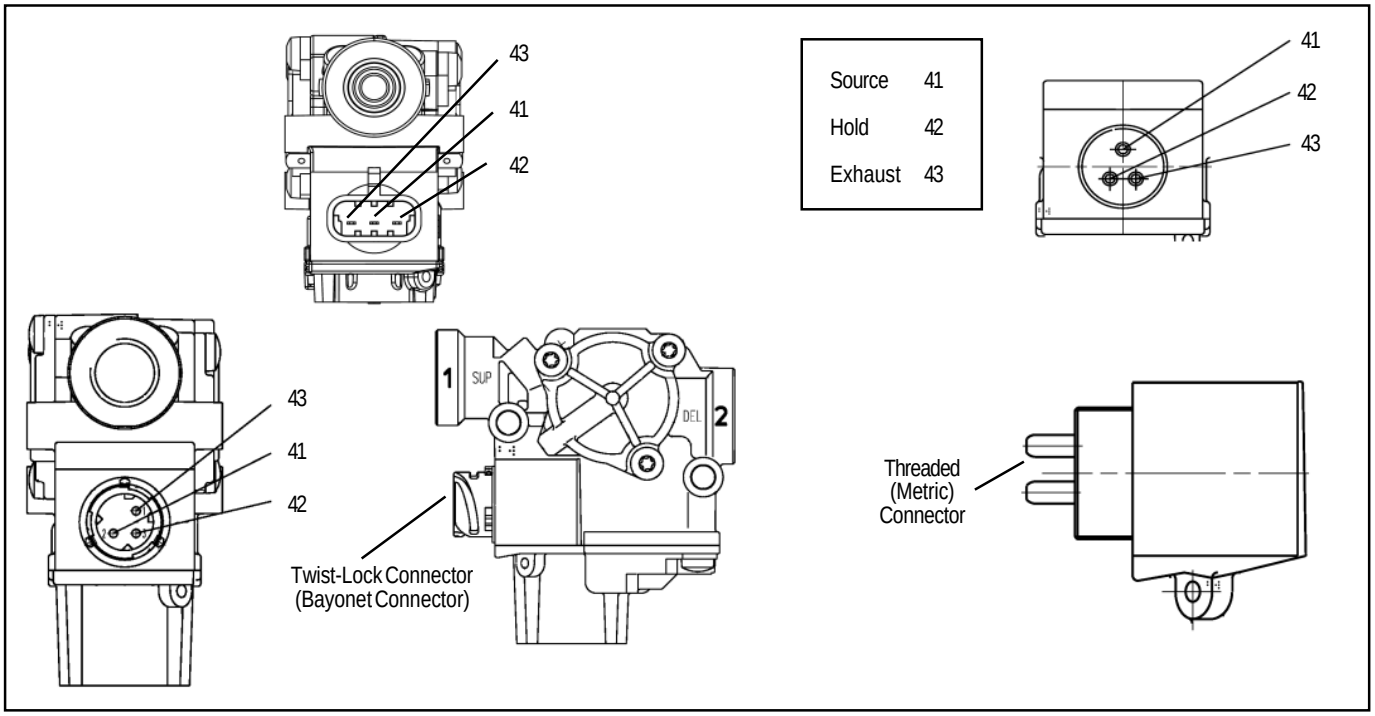
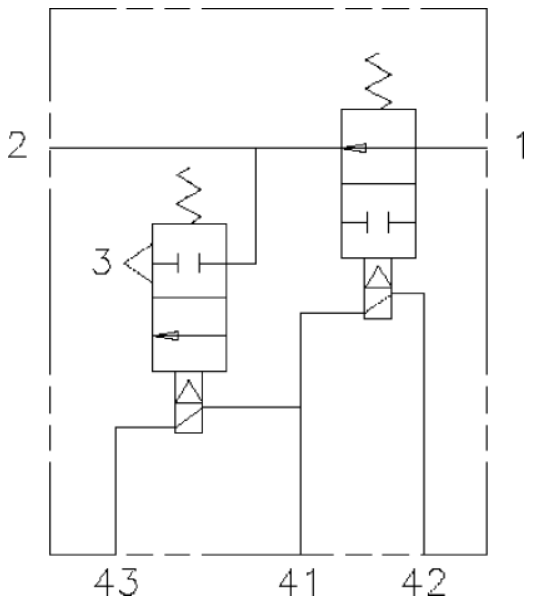


FIGURE 10: ***M-32™ AND M-32QR™ MODULATORS CONNECTOR VIEWS***

2. **Stop the engine and remove ignition key when working under or around the vehicle. When working in the engine compartment, the engine should be shut off and the ignition key should be removed. Where circumstances require that the engine be in operation, EXTREME CAUTION should be used to prevent personal injury resulting from contact with moving, rotating, leaking, heated or electrically charged components.**
3. **Do not attempt to install, remove, disassemble or assemble a component until you have read and thoroughly understand the recommended procedures. Use only the proper tools and observe all precautions pertaining to use of those tools.**
4. **If the work is being performed on the vehicle's air brake system, or any auxiliary pressurized air systems, make certain to drain the air pressure from all reservoirs before beginning ANY work on the vehicle. If the vehicle is equipped with an AD-IS™ air dryer system or a dryer reservoir module, be sure to drain the purge reservoir.**
5. **Following the vehicle manufacturer's recommended procedures, deactivate the electrical system in a manner that safely removes all electrical power from the vehicle.**
6. **Never exceed manufacturer's recommended pressures.**
7. **Never connect or disconnect a hose or line containing pressure; it may whip. Never remove a component or plug unless you are certain all system pressure has been depleted.**
8. **Use only genuine Bendix® replacement parts, components and kits. Replacement hardware, tubing, hose, fittings, etc. must be of equivalent size, type and strength as original equipment and be designed specifically for such applications and systems.**
9. **Components with stripped threads or damaged parts should be replaced rather than repaired. Do not attempt repairs requiring machining or welding unless specifically stated and approved by the vehicle and component manufacturer.**
10. **Prior to returning the vehicle to service, make certain all components and systems are restored to their proper operating condition.**
11. **For vehicles with Antilock Traction Control (ATC), the ATC function must be disabled (ATC indicator lamp should be ON) prior to performing any vehicle maintenance where one or more wheels on a drive axle are lifted off the ground and moving.**

MODULATOR REMOVAL

1. Locate the modulator that will be replaced and clean the exterior.
2. Identify and mark or label all air lines and their respective connections on the valve to facilitate ease of installation.
3. Disconnect both air lines and the electrical connector.
4. Remove the modulator from the vehicle.
5. Remove all air line fittings and plugs. **These fittings will be re-used in the replacement modulator.**



Port Designation	
Supply	1
Delivery	2
Exhaust	3

Electrical Control	
Source	41
Hold	42
Exhaust	43

FIGURE 11: ***M-32™ AND M-32QR™ MODULATORS DIN SYMBOL***

MODULATOR INSTALLATION

1. Install all air line fittings and plugs, making certain thread sealing material does not enter the valve.
2. Install the assembled valve on the vehicle.
3. Reconnect both air lines to the valve using the identification made during VALVE REMOVAL step 5.
4. Reconnect the electrical connector to the modulator.
5. After installing the valve, test all air fittings for excessive leakage and tighten as needed.

TECHNICAL INFORMATION

Porting 1 Supply Port (from brake, relay or quick release valve) - 1/2" NPT

1 Delivery Port (brake actuator) - 1/2" NPT

Optional: 1 Push-to-connect for 1/2" tubing

2 NPT supply, PTC delivery

Solenoid Voltage: 12 Volts DC Nominal, optional 24 Volt available.

Weight: 1.7 pounds

Maximum Operating Pressure: 150 psi Gauge

Operating Temperature Range: -40 to 185 degrees Fahrenheit

Pressure Differential: 1 psi maximum (supply to delivery)

Mounting Hole Sizes: 0.33" diameter through body

Bendix

Service Data

SD-03-901

Bendix® QRV™ and QR-1™ Quick Release Valves

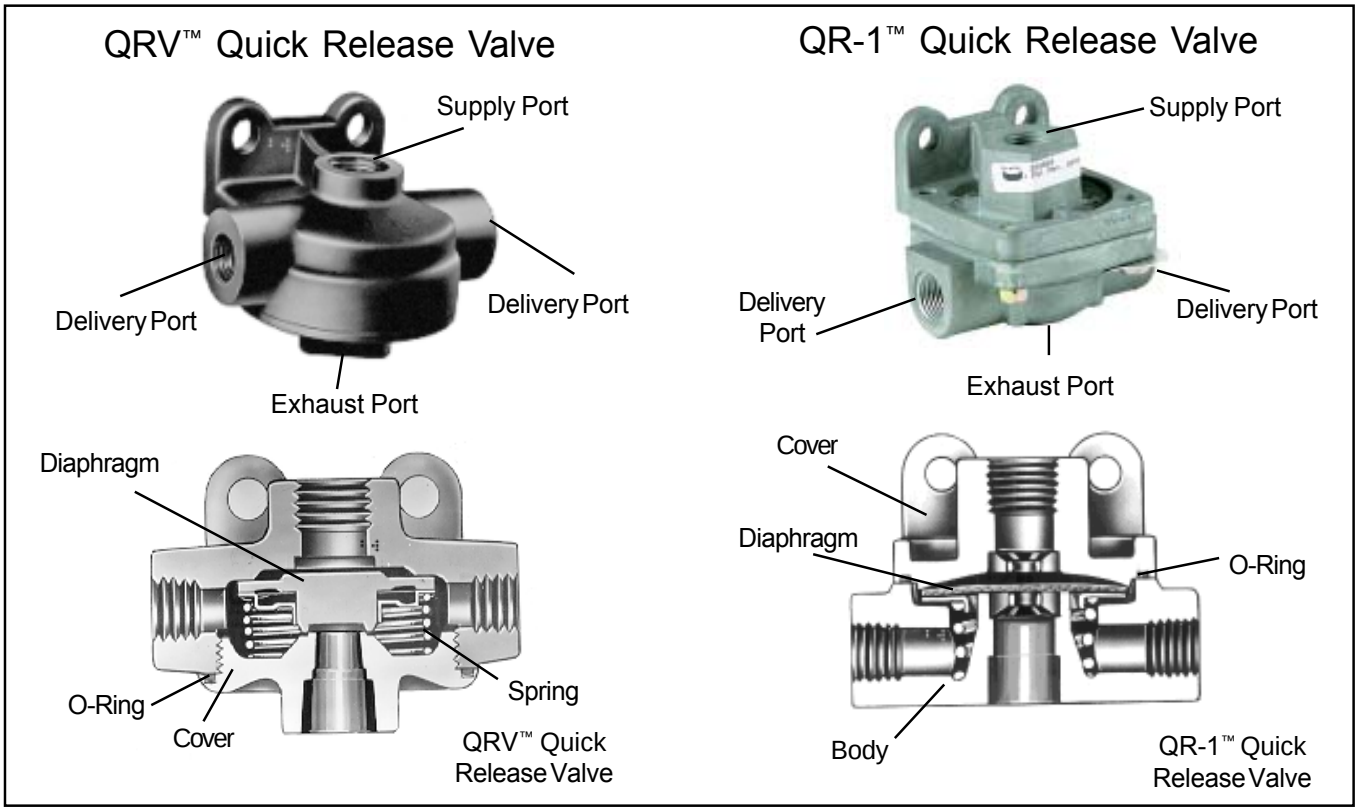


FIGURE 1

DESCRIPTION

The function of the quick release valve is to speed up the exhaust of air from the air chambers. It is mounted close to the chambers it serves. In its standard configuration the valve is designed to deliver within 1 psi of control pressure to the controlled device; however, for special applications the valve is available with greater differential or zero hysteresis. QR-1™ valves also come with optional noise reducing foam crosses or silencers.

Reference Figure 1, two styles of quick release valves are available and are functionally the same; the QRV™ valve, which is of older design and utilizes a spring and spring seat, and the QR-1™ valve, which in its standard configuration does not employ a spring or spring seat.

(Note: QR-1™ valves with a pressure differential employ a spring and spring seat.)

Porting consists of one supply port, two delivery ports and one exhaust port.

OPERATION

When a brake application is made, air pressure enters the supply port; the diaphragm moves down, sealing the exhaust. At the same time, air pressure forces the edges of the diaphragm down and air flows out the delivery ports.

When air pressure being delivered (beneath the diaphragm) equals the pressure being delivered by the brake valve (above the diaphragm), the outer edge of the diaphragm will seal against the body seat. The exhaust port is still sealed by the center portion of the diaphragm when the supply air is released; the air pressure above the diaphragm is released back through the brake valve exhaust; air pressure beneath the diaphragm forces the diaphragm to rise, opening the exhaust, allowing delivery air to exhaust.

PREVENTIVE MAINTENANCE

Important: Review the Bendix Warranty Policy before performing any intrusive maintenance procedures. A warranty may be voided if intrusive maintenance is performed during the warranty period.

No two vehicles operate under identical conditions, as a result, maintenance intervals may vary. Experience is a valuable guide in determining the best maintenance interval for air brake system components. At a minimum, the QR-1™ valve should be inspected every 12 months or 3600 operating hours, whichever comes first, for proper operation. Should the QR-1™ valve not meet the elements of the operational tests noted in this document, further investigation and service of the valve may be required.

OPERATING AND LEAKAGE TESTS

While holding a foot brake valve application:

1. Coat the exhaust port with a soap solution; leakage of a 1" bubble in 3 seconds is permitted.
2. Coat the body and cover with a soap solution. No leakage is permitted between body and cover.

If the valve does not function as described, or if leakage is excessive, it is recommended that it be replaced with a new or remanufactured unit, or repaired with genuine Bendix parts.

GENERAL SAFETY GUIDELINES

WARNING! PLEASE READ AND FOLLOW THESE INSTRUCTIONS TO AVOID PERSONAL INJURY OR DEATH:

When working on or around a vehicle, the following general precautions should be observed at all times.

1. **Park the vehicle on a level surface, apply the parking brakes, and always block the wheels. Always wear safety glasses.**
2. **Stop the engine and remove ignition key when working under or around the vehicle. When working in the engine compartment, the engine should be shut off and the ignition key should be removed. Where circumstances require that the engine be in operation, EXTREME CAUTION should be used to prevent personal injury resulting from contact with moving, rotating, leaking, heated or electrically charged components.**
3. **Do not attempt to install, remove, disassemble or assemble a component until you have read and thoroughly understand the recommended procedures. Use only the proper tools and observe all precautions pertaining to use of those tools.**
4. **If the work is being performed on the vehicle's air brake system, or any auxiliary pressurized air systems, make certain to drain the air pressure from all reservoirs before beginning ANY work on the vehicle. If the vehicle is equipped with an AD-IS® air dryer system or a dryer reservoir module, be sure to drain the purge reservoir.**
5. **Following the vehicle manufacturer's recommended procedures, deactivate the electrical system in a manner that safely removes all electrical power from the vehicle.**
6. **Never exceed manufacturer's recommended pressures.**
7. **Never connect or disconnect a hose or line containing pressure; it may whip. Never remove a component or plug unless you are certain all system pressure has been depleted.**
8. **Use only genuine Bendix® replacement parts, components and kits. Replacement hardware, tubing, hose, fittings, etc. must be of equivalent size, type and strength as original equipment and be designed specifically for such applications and systems.**
9. **Components with stripped threads or damaged parts should be replaced rather than repaired. Do not attempt repairs requiring machining or welding unless specifically stated and approved by the vehicle and component manufacturer.**
10. **Prior to returning the vehicle to service, make certain all components and systems are restored to their proper operating condition.**
11. **For vehicles with Antilock Traction Control (ATC), the ATC function must be disabled (ATC indicator lamp should be ON) prior to performing any vehicle maintenance where one or more wheels on a drive axle are lifted off the ground and moving.**

REMOVING AND INSTALLING

REMOVING

Block vehicle wheels and/or hold vehicle by means other than air brakes.

Drain all air brake system reservoirs.

Disconnect air lines from valve.

Remove mounting bolts, then valve.

INSTALLING

Mount the valve with exhaust port pointing down; securely tighten mounting bolts.

Connect the air lines to valve (brake valve application line to top port; brake chamber line to side ports.)

DISASSEMBLY

QRV™ VALVE

1. Using a wrench on square portion of exhaust port, remove the cover.
2. Remove the spring, spring seat and diaphragm. Remove the cover o-ring.

QR-1™ VALVE

1. Remove the four screws.
2. Remove the spring and spring seat (if so equipped).
3. Remove the diaphragm.
4. Remove the cover o-ring.

CLEANING AND INSPECTION

Clean all metal parts in mineral spirits. Wipe all rubber parts clean.

It is recommended that all rubber parts and any other part showing signs of wear or deterioration be replaced with genuine Bendix parts.

ASSEMBLY

QRV™ VALVE

1. Position the spring seat over the diaphragm and then install it into body.
2. Install the spring and cover o-ring.
3. Install the cover; tighten securely. (Torque to 150-400 inch pounds.)

QR-1™ VALVE

1. If the valve is equipped within spring and spring seat:
   a. Position the spring in body.
   b. Position the diaphragm over spring seat.
   c. Install the o-ring in the cover groove; install the cover and tighten the screws evenly and securely. (Torque to 30-60 inch pounds.)
2. If the valve is not equipped with spring and spring seat:
   a. Install the diaphragm.
   b. Install the o-ring in the cover groove; install the cover and tighten theh screws evenly and securely. (Torque to 30-60 inch pounds.)
3. Perform tests as outlined in “Operating and Leakage Tests” section.

Bendix

Service Data

SD-03-1064

Bendix® R-12™ & R-14™ Relay Valves

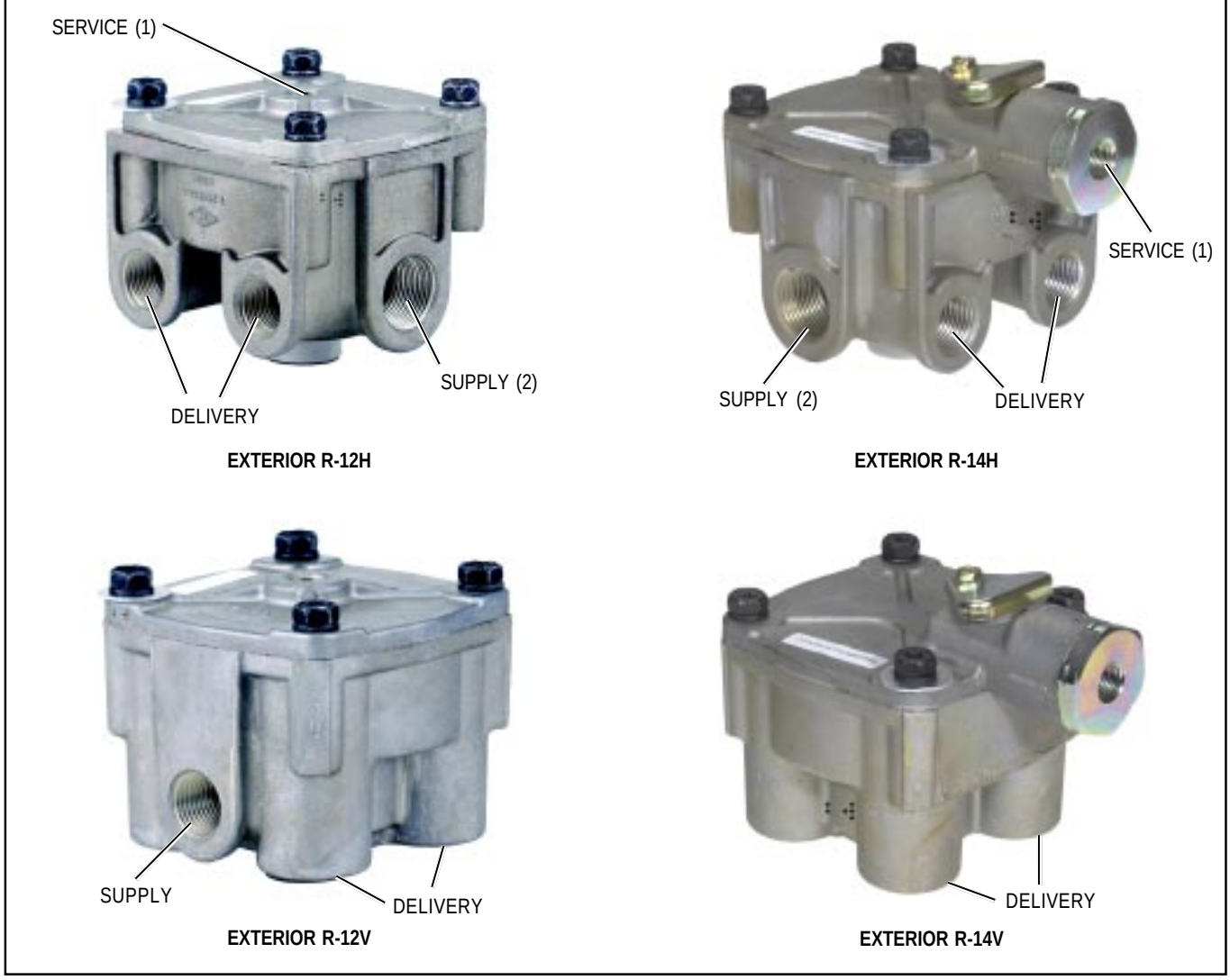


FIGURE 1 - ***EXTERIOR VIEWS***

DESCRIPTION

The relay valve in an air brake system functions as a relay station to speed up the application and release of the brakes. The valve is normally mounted at the rear of the vehicle in proximity to the chambers it serves. The valve operates as a remote controlled brake valve that delivers or releases air to the chambers in response to the control air delivered to it from the foot brake valve or other source.

The R-12™ and R-14™ relay valves are designed for either reservoir or frame mounting. A universal mounting bracket is furnished that permits easy interchange with other Bendix relay valves. Both valves are available in the two body styles illustrated in Figure 1. The R-14™ valve differs from the R-12™ valve in that it incorporates a quick release and anti-compounding feature located above its horizontal service port. The R-14™ valve's anti-compound feature allows it to be conveniently used as either a service or spring brake relay valve. An exhaust cover is installed that protects the 1/8" balance port when the R-14™ valve anti-compound feature is not in use.

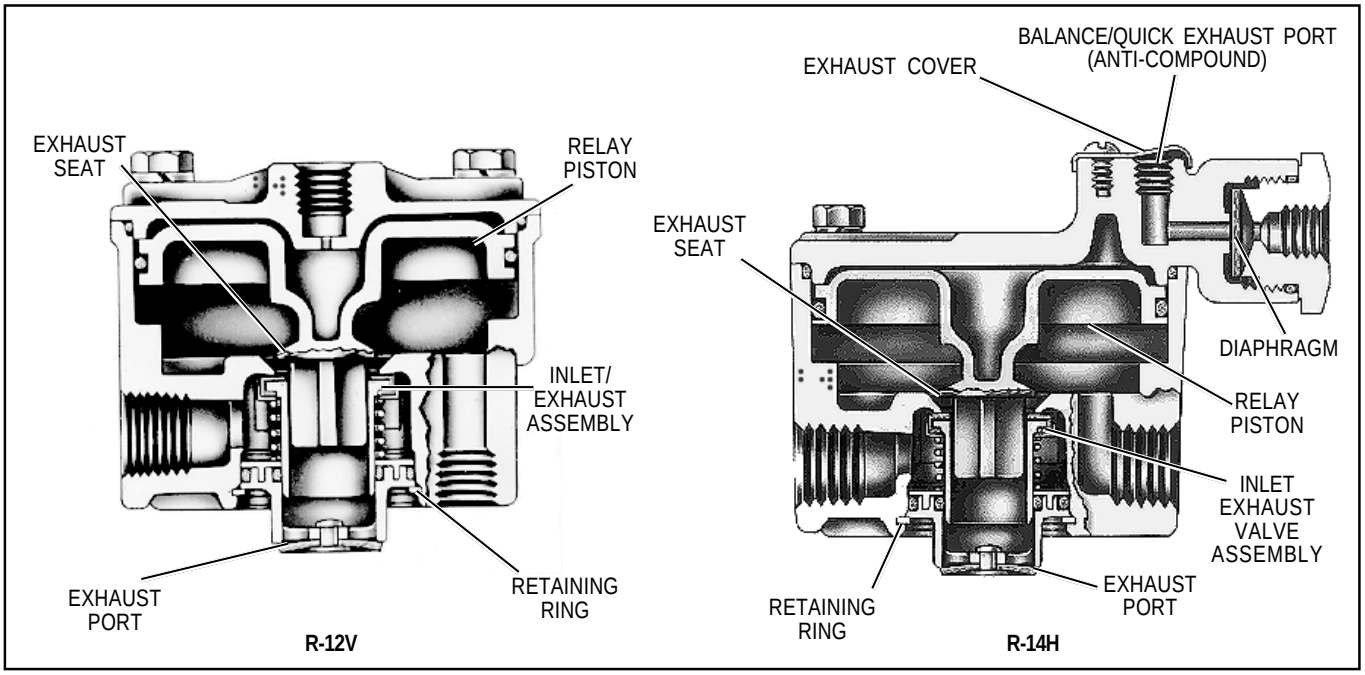


FIGURE 2 - ***SECTIONAL VIEWS***

All parts are interchangeable between the R-12™ and R-14™ valves with the exception of the detail components of the R-14™ valve cover. Both valves make extensive use of non-metallic internal components. For ease of servicing, the inlet/exhaust valve can be replaced without the need for line removal.

OPERATION

APPLICATION

Air pressure delivered to the service port enters the small cavity above the piston and moves the piston down. The exhaust seat moves down with the piston and seats on the inner or exhaust portion of the inlet/exhaust valve, sealing off the exhaust passage. At the same time, the outer or inlet portion of the inlet/exhaust valve moves off its seat, permitting supply air to flow from the reservoir, past the open inlet valve and into the brake chambers.

BALANCE

The air pressure being delivered by the open inlet valve also is effective on the bottom area of the relay piston. When air pressure beneath the piston equals the service air pressure above, the piston lifts slightly and the inlet spring returns the inlet valve to its seat. The exhaust remains closed as the service line pressure balances the delivery pressure. As delivered air pressure is changed, the valve reacts instantly to the change, holding the brake application at that level.

EXHAUST OR RELEASE

When air pressure is released from the service port and air pressure in the cavity above the relay piston is exhausted, air pressure beneath the piston lifts the relay piston and the exhaust seat moves away from the exhaust valve, opening the exhaust passage. With the exhaust passage open, the air pressure in the brake chambers is then permitted to exhaust through the exhaust port, releasing the brakes.

ANTI-COMPOUNDING (SIMULTANEOUS SERVICE AND PARK APPLICATION)

In those applications where the R-14™ relay valve is used to control spring brake chambers, the anti-compound feature may be utilized. With the anti-compound feature of the R-14™ valve connected, a service application made while the vehicle is parked is countered by a release of the parking brakes. To utilize this feature, the exhaust cover of the quick release portion of the R-14™ valve is removed and a line is installed which is connected to the delivery of the service brake valve or relay valve. With no air pressure at the service port of the R-14™ valve, the parking brakes are applied. If a service brake application is made, air from the service brake valve enters the exhaust port of the quick release of the R-14™ valve and moves the diaphragm, blocking the service port. Air then proceeds into the cavity above the relay piston, forces the piston down, closing the exhaust and opening the inlet to deliver air to the spring brake cavity as described under the section of this manual entitled *Application*.

PREVENTIVE MAINTENANCE

Important: Review the Bendix Warranty Policy before performing any intrusive maintenance procedures. A warranty may be voided if intrusive maintenance is performed during the warranty period.

No two vehicles operate under identical conditions, as a result, maintenance intervals may vary. Experience is a valuable guide in determining the best maintenance interval for air brake system components. At a minimum, the valve should be inspected every 6 months or 1500 operating hours, whichever comes first, for proper operation. Should the valve not meet the elements of the operational tests noted in this document, further investigation and service of the valve may be required.

OPERATIONAL AND LEAKAGE TEST

1. Chock the wheels, fully charge the air brake system and adjust the brakes.
2. Make several brake applications and check for prompt application and release at each wheel.
3. Check for inlet valve and o-ring leakage.
   A. Make this check with the service brakes released when the R-12™ or R-14™ valve is used to control the service brakes.
   B. Make the check with the spring brakes applied (PARK) when the R-14™ valve is used to control the spring brakes. Coat the exhaust port and the area around the retaining ring with a soap solution; a 1" bubble in 3 seconds leakage is permitted.
4. Check for exhaust valve leakage.
   A. Make this check with the service brakes fully applied if the R-12™ or R-14™ valve control the service brakes.
   B. Make this check with the spring brakes fully released if the R-14™ valve is used to control the spring brakes. Coat the exhaust port with a soap solution; a 1" bubble in 3 seconds leakage is permitted. Coat the outside of the valve where the cover joins the body to check for seal ring leakage; no leakage is permitted.
5. If the R-14™ valve is used to control the spring brakes, place the park control in the released position and coat the balance port with a soap solution to check the diaphragm and its seat. Leakage equivalent to a 1" bubble in 3 seconds is permitted.

Note: If the anti-compound feature is in use, the line attached to the balance port must be disconnected to perform this test.

If the valves do not function as described above, or if leakage is excessive, it is recommended that the valves be replaced with new or remanufactured units or repaired with genuine Bendix parts, available at any authorized Bendix parts outlet.

REMOVAL AND INSTALLATION

REMOVAL

1. Block and hold vehicle by means other than air brakes.
2. Drain air brake system reservoirs.
3. If entire valve is to be removed, identify air lines to facilitate installation.
4. Disconnect air lines from valve.*
5. Remove valve from reservoir or if remotely mounted, remove mounting bolts and then valve.

*It is generally not necessary to remove entire valve to service the inlet/exhaust valve. The inlet/exhaust valve insert can be removed by removing the snap ring, exhaust cover assembly and then inlet/exhaust valve.

Caution: Drain all reservoirs before attempting to remove the inlet exhaust valve.

DISASSEMBLY

Note: Prior to disassembly, mark the location of the mounting bracket to the cover and the cover to the body.

1. Remove the four (4) cap screws and lockwashers securing the cover to the body.
2. Remove the cover, sealing ring, and mounting bracket.
3. Remove the piston and o-ring from the body.
4. While depressing the exhaust cover, remove the retaining ring and slowly relax the spring beneath the exhaust cover.
5. Remove the exhaust cover assembly and o-rings.
6. Remove the inlet/exhaust valve return spring from the body.
7. Remove the inlet/exhaust valve from the body.
8. Remove the valve retainer from the inlet/exhaust valve.
9. Remove the Phillips head screw and exhaust cover from the R-14™ valve cover.
10. Remove the service port cap nut and o-ring from the R-14™ valve.
11. Remove the diaphragm from the R-14™ valve cover.

CLEANING AND INSPECTION

1. Wash all metal parts in mineral spirits and dry them thoroughly.

   (**Note:** When rebuilding, all springs and all rubber parts should be replaced.)
2. Inspect all metal parts for deterioration and wear, as evidenced by scratches, scoring and corrosion.
3. Inspect the exhaust valve seat on the relay piston for nicks and scratches which could cause excessive leakage.
4. Inspect the inlet valve seat in the body for scratches and nicks, which could cause excessive leakage.
5. Inspect the exhaust seat of the quick release diaphragm in the R-14™ valve cover and make sure all internal air passages in this area are open and clean and free of nicks and scratches.
6. Replace all parts not considered serviceable during these inspections and all springs and rubber parts. Use only genuine Bendix replacement parts, available from any authorized Bendix parts outlet.

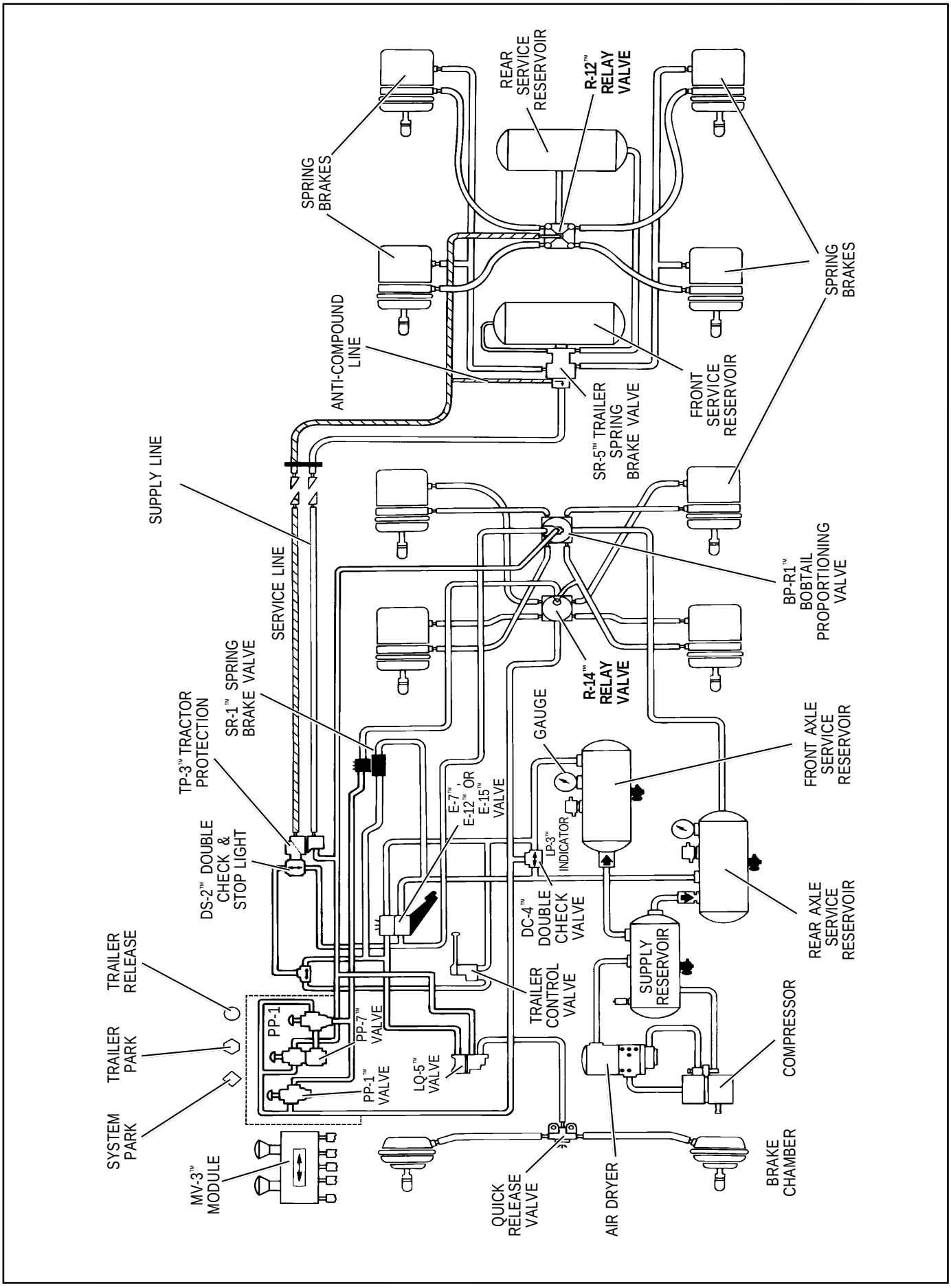


*FIGURE 3 - **TYPICAL PIPING SCHEMATIC***

ASSEMBLY

Note: All torque specified in this manual are assembly torque and can be expected to fall off slightly after assembly. **Do not re-torque** after initial assembly torque fall. For assembly, hand wrenches are recommended.

Prior to assembly, lubricate all o-rings, o-ring bores and any sliding surface with a silicone lubricant equivalent to Dow Corning #10.

1. Install large piston o-ring on piston.
2. Install inner and outer o-rings in the exhaust cover assembly.
3. Install the sealing ring on the cover.
4. Install piston in body, taking care not to damage the piston o-ring.
5. Noting the reference marks made during disassembly, install the cover on the valve body and the mounting bracket on the cover.
6. Secure the mounting bracket and cover to the body using the four (4) cap screws and lock washers. Torque to 80-120 inch pounds.
7. Install the valve retainer on the inlet/exhaust valve and install in the body.
8. Install the inlet/exhaust valve return spring in the body.
9. Install the exhaust cover assembly in the body, taking care not to damage the o-ring.
10. While depressing the exhaust cover, install the retaining ring. Make certain the retainer is completely seated in its groove in the body.
11. Install the R-14™ valve service port cap nut o-ring on the cap nut.
12. Install the diaphragm in the R-14™ valve cover making certain it is positioned between the guide ribs in the cover.
13. Install the service port cap nut and torque to 150 inch pounds.
14. If the quick release exhaust port was protected with an exhaust cover, install the cover using the #10-24 Phillips head screw. Torque to approx. 15-25 inch pounds.
15. Test the valves as outlined in the *Operational and Leakage Test* section before returning the valve to service.

INSTALLATION

1. Clean air lines.
2. Inspect all lines and/or hoses for damage and replace as necessary.
3. Install valve and tighten mounting bolts.
4. Connect air lines to valve (plug any unused ports).
5. Test valve as outlined in *Operational and Leakage Tests*.

WARNING! PLEASE READ AND FOLLOW THESE INSTRUCTIONS TO AVOID PERSONAL INJURY OR DEATH:

When working on or around a vehicle, the following general precautions should be observed at all times.

1. **Park the vehicle on a level surface, apply the parking brakes, and always block the wheels. Always wear safety glasses.**
2. **Stop the engine and remove ignition key when working under or around the vehicle. When working in the engine compartment, the engine should be shut off and the ignition key should be removed. Where circumstances require that the engine be in operation, EXTREME CAUTION should be used to prevent personal injury resulting from contact with moving, rotating, leaking, heated or electrically charged components.**
3. **Do not attempt to install, remove, disassemble or assemble a component until you have read and thoroughly understand the recommended procedures. Use only the proper tools and observe all precautions pertaining to use of those tools.**
4. **If the work is being performed on the vehicle's air brake system, or any auxiliary pressurized air systems, make certain to drain the air pressure from all reservoirs before beginning ANY work on the vehicle. If the vehicle is equipped with an AD-IS® air dryer system or a dryer reservoir module, be sure to drain the purge reservoir.**
5. **Following the vehicle manufacturer's recommended procedures, deactivate the electrical system in a manner that safely removes all electrical power from the vehicle.**
6. **Never exceed manufacturer's recommended pressures.**
7. **Never connect or disconnect a hose or line containing pressure; it may whip. Never remove a component or plug unless you are certain all system pressure has been depleted.**
8. **Use only genuine Bendix® replacement parts, components and kits. Replacement hardware, tubing, hose, fittings, etc. must be of equivalent size, type and strength as original equipment and be designed specifically for such applications and systems.**
9. **Components with stripped threads or damaged parts should be replaced rather than repaired. Do not attempt repairs requiring machining or welding unless specifically stated and approved by the vehicle and component manufacturer.**
10. **Prior to returning the vehicle to service, make certain all components and systems are restored to their proper operating condition.**

Bendix® Service Data

SD-03-4508

Bendix® SR-1™ Spring Brake Valve

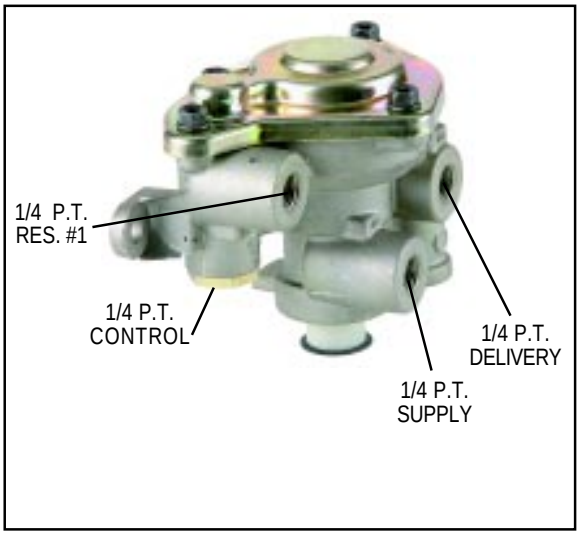


FIGURE 1 - EXTERIOR VIEW

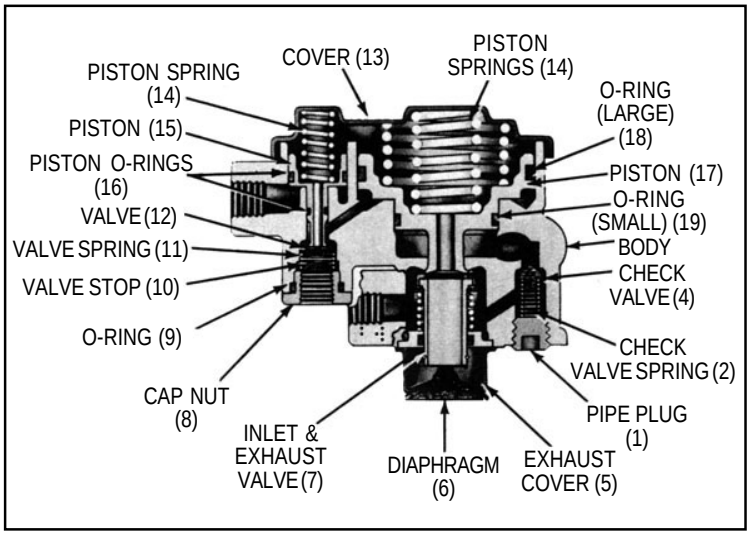


FIGURE 2 - SECTIONAL VIEW

DESCRIPTION:

The SR-1™ spring brake valve is used in dual or "split" air brake systems equipped with spring brake actuators. The function of the SR-1™ valve is to supply a specific, limited hold-off pressure to the spring brakes, and in the event of loss of No. 1 service air pressure, to modulate the spring brakes through the use of the service brake valve.

The valve has four identified 1/4" N.P.T.F. ports and a diaphragm protected exhaust port. Two 5/16" diameter holes are provided in the integral mounting bracket of the valve body. The SR-1™ valve must be mounted with the exhaust port down toward the road surface.

OPERATION - INITIAL AIR SYSTEM CHARGE

Upon initial charge, air from #1 & #2 service reservoirs flows through the park control valve and enters the SR-1™ valve supply port. Air entering the supply port flows past inlet and exhaust valve B to the underside of piston B and out the delivery port of the SR-1™ valve to the emergency air connection at the spring brake actuator. Note that the springs above piston B force it into contact with inlet and exhaust valve B. In the position shown the exhaust is closed and the inlet is open.

Air flowing from the No. 1 reservoir only enters the reservoir port of the SR-1™ valve. This air remains under piston A as system pressure builds. With No. 1 reservoir pressure below approximately 55 P.S.I. the spring above piston A forces it into contact with inlet and exhaust valve A causing the exhaust to seal and the inlet to open.

With air system pressure above approximately 55 P.S.I. in No. 1 & 2 service reservoirs, piston A has moved against the force of the spring above it, allowing the inlet of valve A to close and opening the hollow exhaust passage through piston A.

OPERATION - AIR BRAKE SYSTEM FULLY CHARGED

When air pressure beneath piston B is approximately 95* P.S.I., piston B rises slightly, against the force of the springs above it, allowing the inlet of valve B to close. The exhaust through valve B remains closed. The closing of the inlet portion of valve B retains approximately 95* P.S.I. in the hold- off cavity of the spring brake actuators while allowing full air system pressure to build elsewhere.

*Note: Other spring brake hold-off pressures are supplied according to the vehicle manufacturer's specifications. 95 P.S.I. was chosen only for the purpose of explanation.

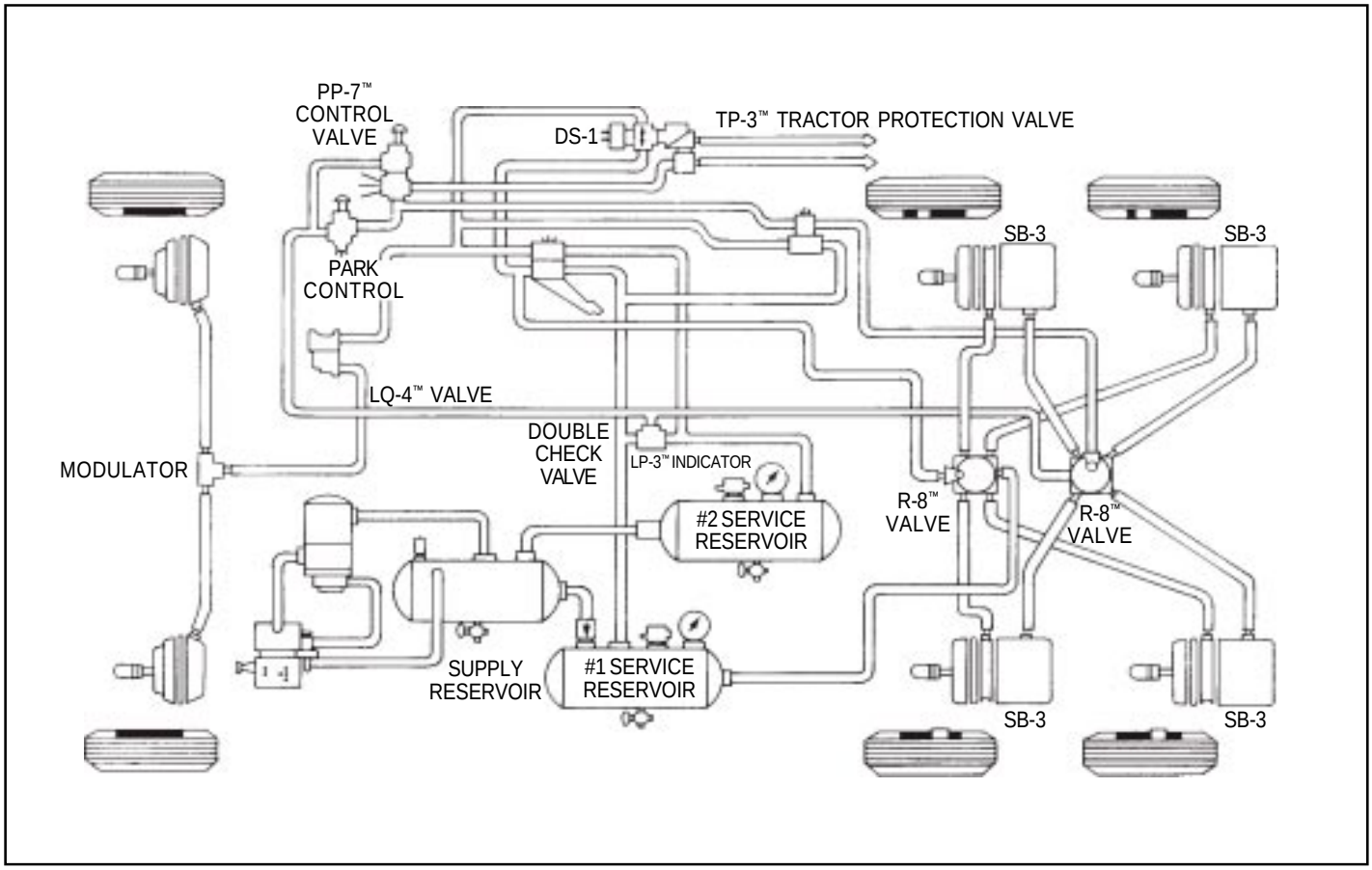


FIGURE 3 - PIPING DIAGRAM

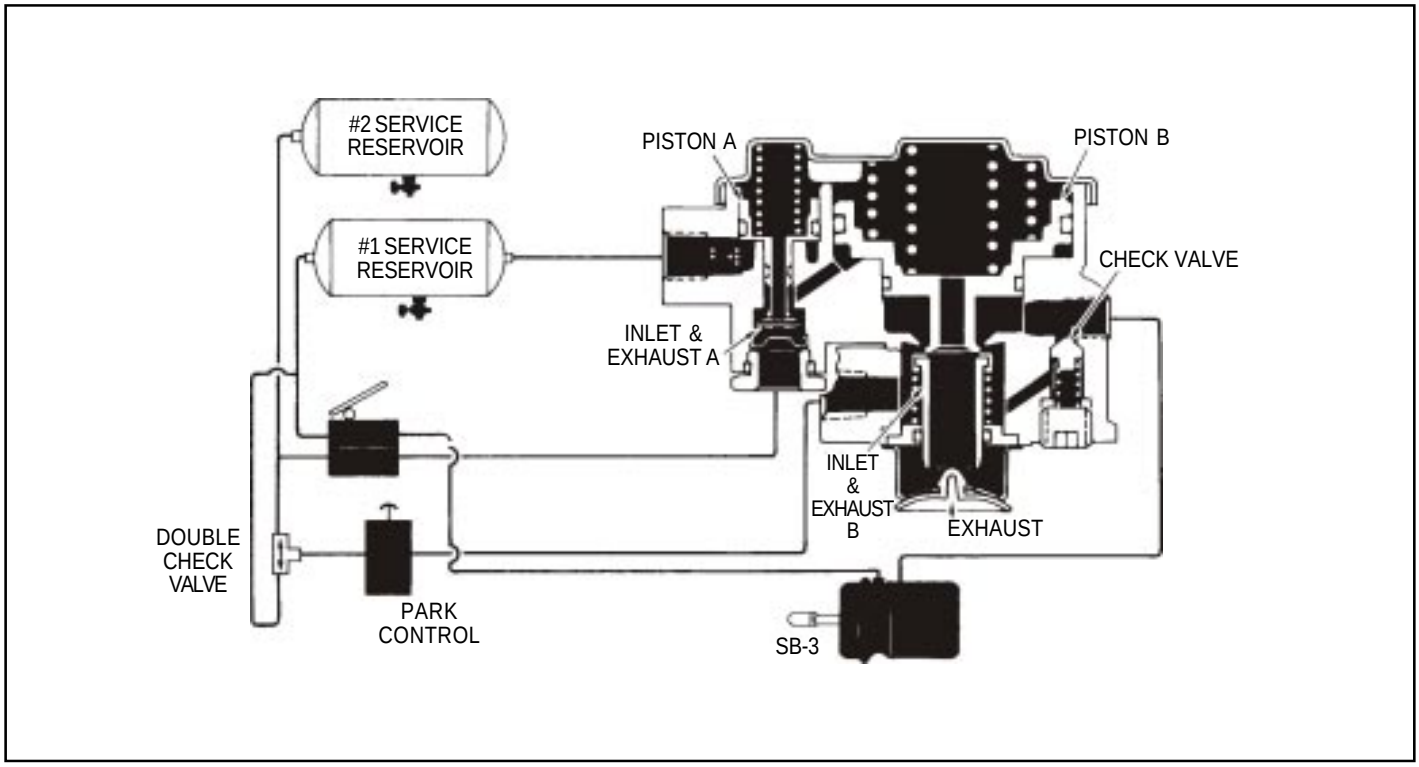


FIGURE 4 - CHARGING - BELOW 55 P.S.I.

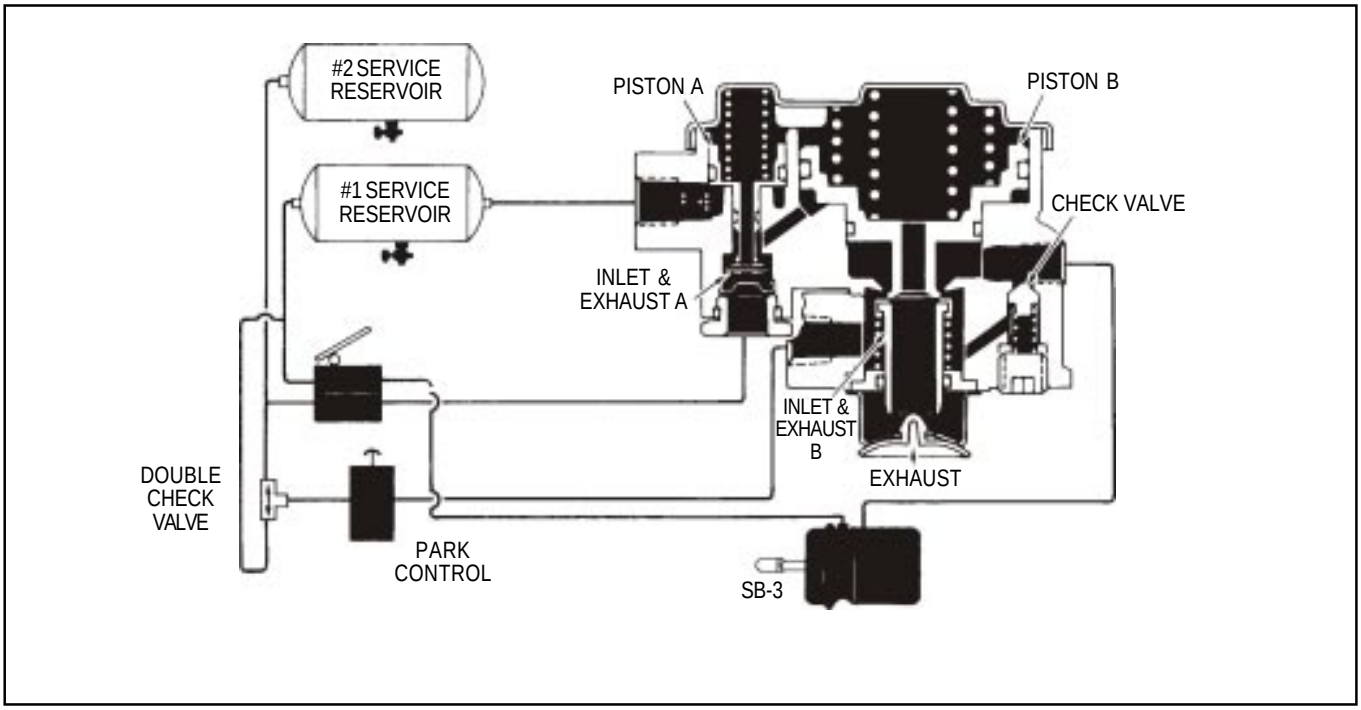


FIGURE 5 - SYSTEM FULLY CHARGED

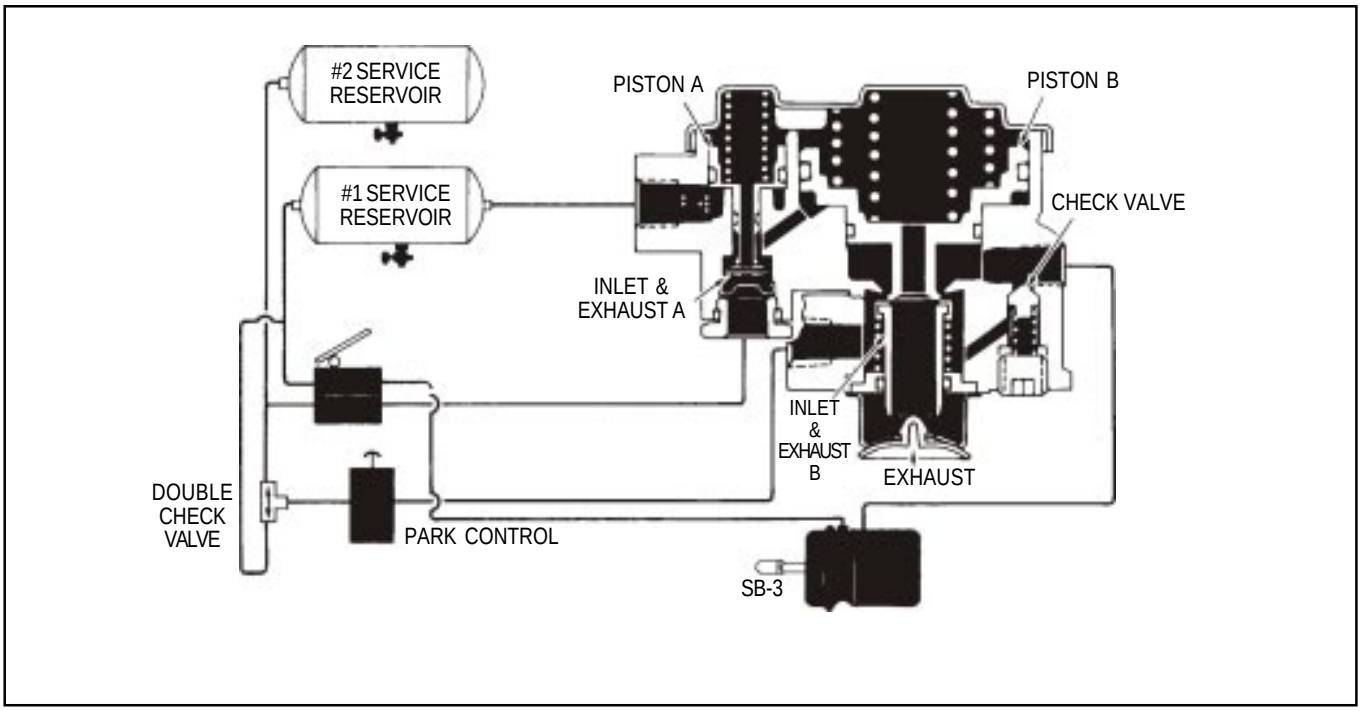


FIGURE 6 - NORMAL SERVICE APPLICATION

OPERATION - NORMAL SERVICE RESERVOIRS 1 & 2 CHARGED

When a service application is made by actuating the dual brake valve, air from the No. 2 delivery circuit is delivered from the brake valve to the control port, and is stopped at the closed inlet of valve A. No movement of the internal components of the SR-1™ valve takes place. Air from the No. 1 delivery circuit of the dual brake valve actuates the service section of the spring brake actuators.

OPERATION - SERVICE APPLICATION WITH LOSS OF NO. 2 RESERVOIR PRESSURE

In the event air pressure is lost in the No. 2 reservoir, the No. 1 reservoir and the parking control valve will be protected via the double and single check valves in the air system. A service application of the foot brake valve in this situation results in little or no air being delivered from the No. 2 delivery circuit to the control port of the SR-1™ valve. No movement of the SR-1™ valve internal components takes place. Braking is assured because the No. 1 service reservoir is protected by a check valve and the No. 1 delivery circuit of the dual

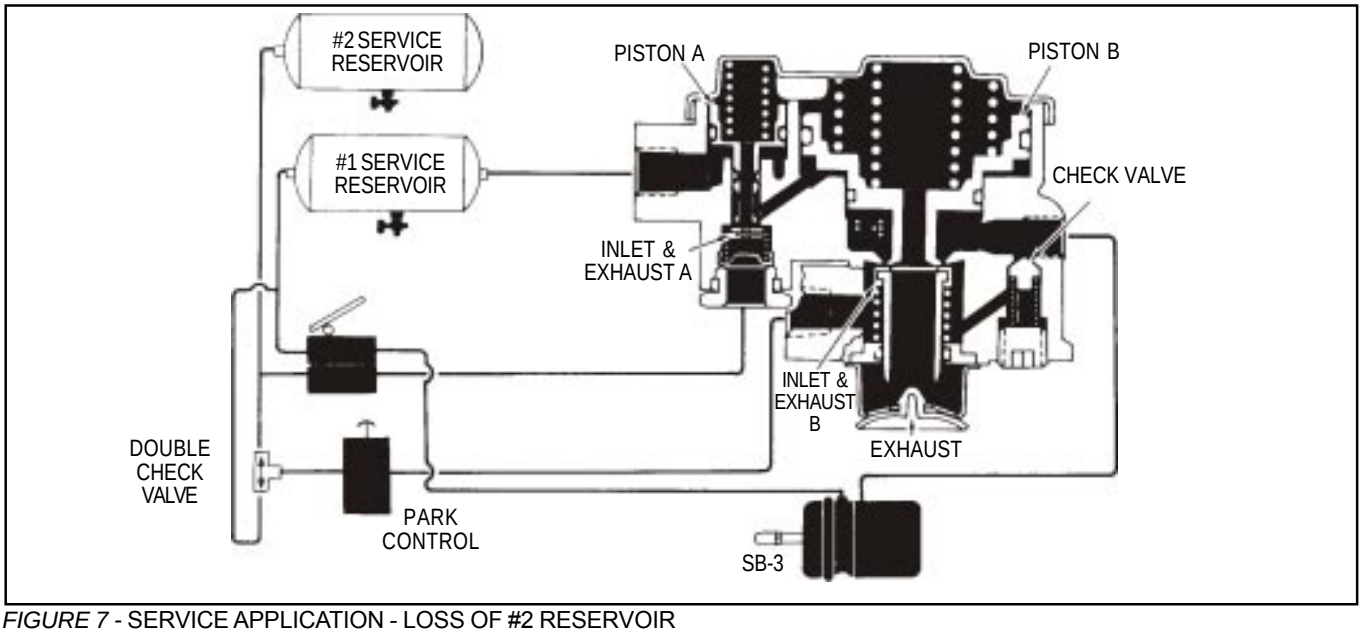


FIGURE 7 - SERVICE APPLICATION - LOSS OF #2 RESERVOIR

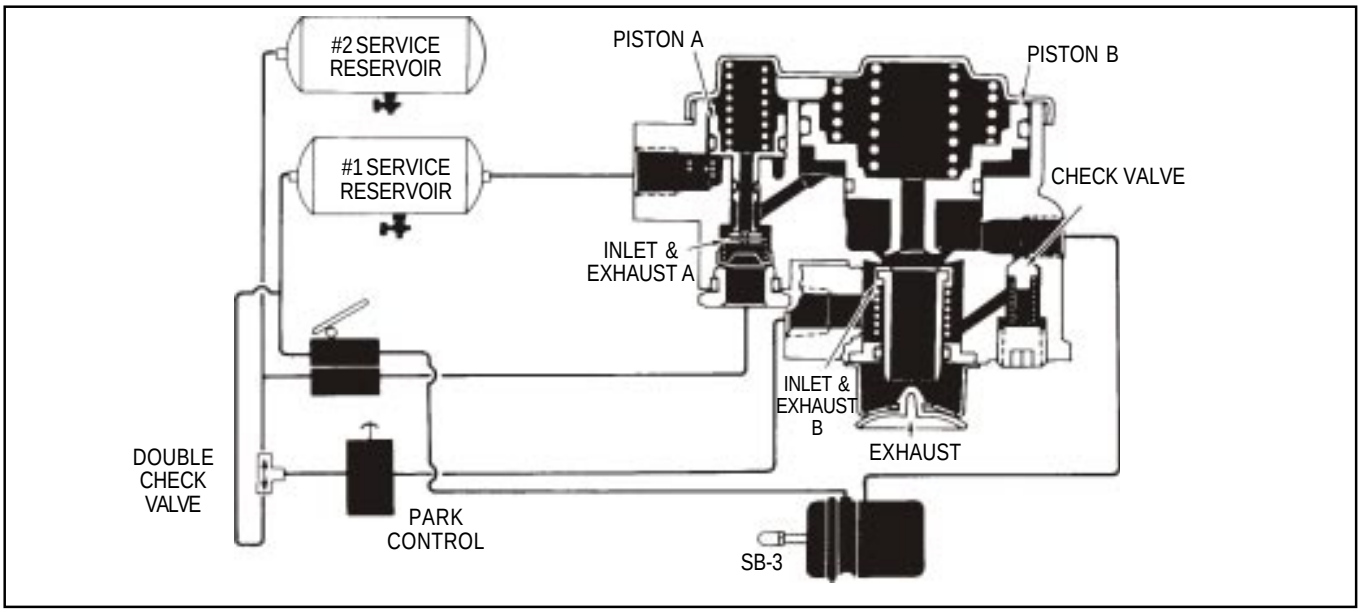


FIGURE 8 - SERVICE APPLICATION - LOSS OF #1 RESERVOIR

brake valve will apply the service section of the spring brake actuators.

OPERATION - SERVICE APPLICATION WITH LOSS OF NO. 1 RESERVOIR PRESSURE

If air pressure in the No. 1 service reservoir falls below approximately 55 P.S.I., the pressure beneath piston A is insufficient to resist the spring force above and piston A moves into contact with valve A. Initial contact between piston A and valve A closes the hollow exhaust passage of piston A. Continued movement of the piston opens the inlet of valve A.

The No. 2 service reservoir and the park control valve are protected from pressure loss by the action of the double check valve.

When a service application of the dual brake valve is made, air delivered from the No. 2 delivery circuit of the dual brake valve enters the SR-1™ valve control port. Air entering the control port moves past the inlet of valve A and is conducted through a passage in the body to the underside of piston B. The air pressure moves piston B up, opening the exhaust of valve B. When the exhaust of valve B opens, air pressure trapped in the emergency section of the spring brake actuator is allowed to escape, resulting in an emergency brake application. The air pressure released from the spring brake is proportional to the air pressure delivered to the control port of the SR-1™ valve by the No. 2 delivery of the dual brake valve.

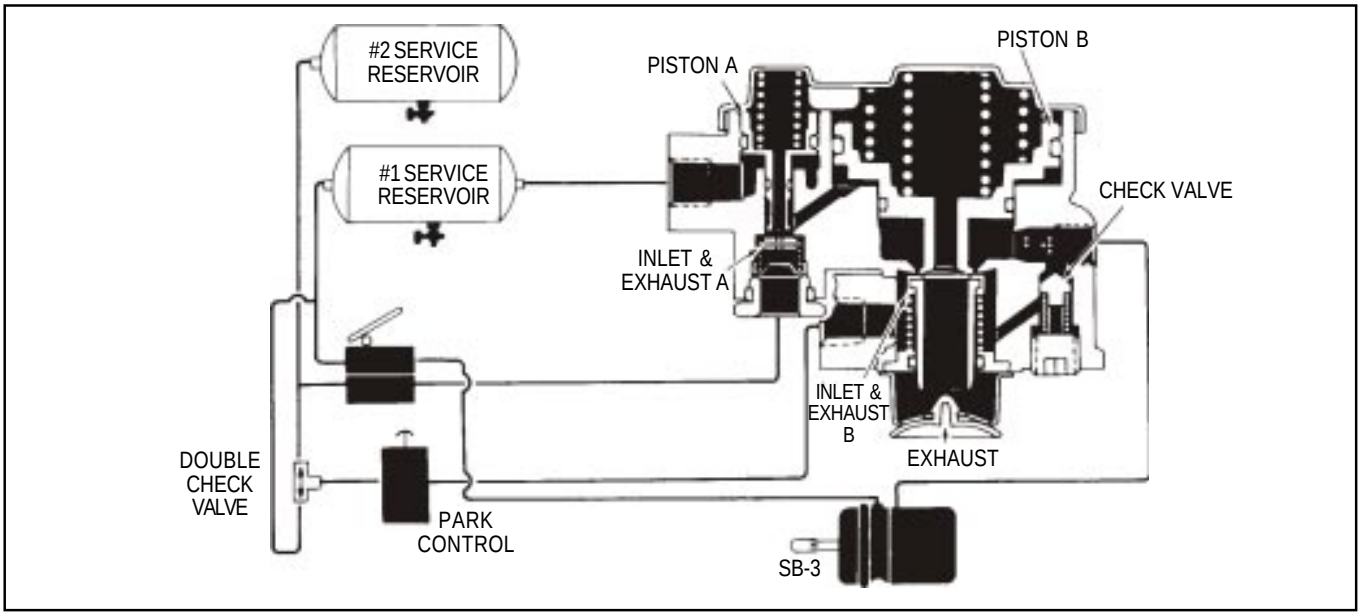


FIGURE 9 - PARK APPLICATION

OPERATION - PARKING

If both systems #1 and #2 are intact and the park control valve is placed in the "park" or exhaust position, the SR-1™ valve supply of air pressure and the air pressure in the spring brake actuator cavities is exhausted. The single check valve in the SR-1™ valve assists this exhaust of air pressure by allowing the air below piston B to flow back out the open exhaust of the park control valve. When air pressure below piston B has dropped sufficiently, piston B moves down, opening the inlet of valve B and providing an additional exhaust passage for air exhausting through the SR-1™ valve from the spring brakes.

PREVENTIVE MAINTENANCE

Important: Review the Bendix Warranty Policy before performing any intrusive maintenance procedures. A warranty may be voided if intrusive maintenance is performed during the warranty period.

No two vehicles operate under identical conditions, as a result, maintenance intervals may vary. Experience is a valuable guide in determining the best maintenance interval for air brake system components. At a minimum, the SR-1™ valve should be inspected every 6 months or 1500 operating hours, whichever comes first, for proper operation. Should the SR-1™ valve not meet the elements of the operational tests noted in this document, further investigation and service of the valve may be required.

SERVICE CHECKS

OPERATING CHECKS

Block all wheels and hold by means other than vehicle brakes. Charge air brake system to governor cut-out pressure.

1. Place parking control valve in the "park" position. Observe that the spring brake actuators apply promptly. In the delivery port of the valve install a test gauge known to be accurate. Place the parking control valve in the "release" position. Observe that the spring brake actuators release fully.
2. With the parking control valve in the "release" position, note the gauge pressure reading. (Check the vehicle manual for the correct spring brake actuator hold-off pressure.) If the pressure reading is incorrect, the valve must be repaired or replaced.
3. Place the parking control valve in the "park" position, the gauge reading should drop to zero promptly. A slow release of pressure may indicate faulty operation of the single check valve (within the modulating valve.)
4. Place the parking control valve in the "release" position. Locate the number one service reservoir and drain it completely.

   Apply the foot brake valve several times and note that the pressure reading on the gauge decreases each time the foot brake valve is applied. After several applications, pressure on the gauge will drop to the point where release of the spring brake actuators will no longer occur.

LEAKAGE CHECK

With the air system fully charged and the parking control valve in the "release" position, coat the exhaust port and around the valve corner with a soap solution. Slight leakage is permitted.

If the SR-1™ spring brake valve does not function as described above, or leakage is excessive, it is recommended that it be repaired or replaced with a genuine Bendix service replacement valve.

Note: A maintenance kit for the SR-1™ spring brake valve is available from any authorized Bendix outlet. All parts necessary for minor repair are included.

REMOVAL

1. Prior to removing the SR-1™ valve apply the parking brakes and drain all the vehicle reservoirs.
2. Identify all air lines before disconnecting.
3. Remove the two mounting bolts from the SR-1™ valve and remove the valve.

DISASSEMBLY (REFER TO FIGURE 2)

1. Remove the socket head pipe plug (1).
2. Remove the check valve spring (2) and the check valve (4).
3. Remove the two phillips head screws and remove the exhaust cover (5).
4. Separate the exhaust diaphragm (6) from the cover.
5. Remove the inlet and exhaust valve assembly (7).
6. Remove the inlet and exhaust valve cap nut (8) and separate the cap nut o-ring (9).
7. Remove the valve stop (10) valve spring (11) and inlet and exhaust valve (12).
8. Remove the four phillips head screws and lockwashers that secure the cover to the body. Caution: the cover is under a spring load, and should be held while removing the screws.
9. Remove the cover (13) and the three piston springs (14). Note: Some SR-1™ valve piece numbers have one large piston spring.
10. Remove the small piston (15) and the small and large o-rings (16).
11. Remove the large piston (17). Remove piston o-rings (18) & (19).

CLEANING & INSPECTION

Inspect all parts for excessive wear or deterioration.

Inspect the valve seats for nicks or burrs.

Check the springs for cracks or corrosion.

Replace all rubber parts and any part not found to be serviceable during inspection. Use only genuine Bendix replacement parts.

ASSEMBLY (REFER TO FIGURE 2)

Prior to assembly of the SR-1™ spring brake valve, lubricate all o-rings, o-ring grooves, and piston bores with Bendix silicone lubricant BW-650-M piece number 291126.

Note: All torques specified in this manual are assembly torques and can be expected to fall off, after assembly is accomplished. Do not retorque after initial assembly torques fall.

1. Assemble the check valve (4), and valve spring (2) and install in body.
2. Apply pipe sealant to the socket head pipe plug (1) and install in the body. Tighten to 130-170 inch pounds torque.
3. Install inlet and exhaust valve assembly (7) in valve body.
4. Secure the exhaust cover (5) with two 10-24 phillips screws and lockwashers. Tighten to 20-30 inch pounds torque.
5. Install exhaust diaphragm (6) into the exhaust cover.
6. Place inlet exhaust valve (12) in the body. Install the valve spring (11) and valve stop (10).
7. Install o-ring (9) on cap nut and install cap nut (8) in body. Tighten to 100-125 inch pounds torque.
8. Install the small and large o-rings (16) on the small diameter piston (15) and install piston in the body.
9. Install large o-ring (18) and small o-ring (19) on the large diameter piston and install piston in the body.
10. Install the piston springs (14) in their respective pistons.
11. Secure the cover to body using four 1/4"-20 phillips head screws and lockwashers. Tighten to 50-80 inch pounds torque.

TESTING THE REBUILT SR-1™ SPRING BRAKE VALVE

Test the rebuilt SR-1™ spring brake valve by performing the operation and leakage test outlined in the “Service Checks” section of this manual.

WARNING! PLEASE READ AND FOLLOW THESE INSTRUCTIONS TO AVOID PERSONAL INJURY OR DEATH:

When working on or around a vehicle, the following general precautions should be observed at all times.

1. **Park the vehicle on a level surface, apply the parking brakes, and always block the wheels. Always wear safety glasses.**
2. **Stop the engine and remove ignition key when working under or around the vehicle. When working in the engine compartment, the engine should be shut off and the ignition key should be removed. Where circumstances require that the engine be in operation, EXTREME CAUTION should be used to prevent personal injury resulting from contact with moving, rotating, leaking, heated or electrically charged components.**

3. **Do not attempt to install, remove, disassemble or assemble a component until you have read and thoroughly understand the recommended procedures. Use only the proper tools and observe all precautions pertaining to use of those tools.**
4. **If the work is being performed on the vehicle's air brake system, or any auxiliary pressurized air systems, make certain to drain the air pressure from all reservoirs before beginning ANY work on the vehicle. If the vehicle is equipped with an AD-IS® air dryer system or a dryer reservoir module, be sure to drain the purge reservoir.**
5. **Following the vehicle manufacturer's recommended procedures, deactivate the electrical system in a manner that safely removes all electrical power from the vehicle.**
6. **Never exceed manufacturer's recommended pressures.**
7. **Never connect or disconnect a hose or line containing pressure; it may whip. Never remove a component or plug unless you are certain all system pressure has been depleted.**
8. **Use only genuine Bendix® replacement parts, components and kits. Replacement hardware, tubing, hose, fittings, etc. must be of equivalent size, type and strength as original equipment and be designed specifically for such applications and systems.**
9. **Components with stripped threads or damaged parts should be replaced rather than repaired. Do not attempt repairs requiring machining or welding unless specifically stated and approved by the vehicle and component manufacturer.**
10. **Prior to returning the vehicle to service, make certain all components and systems are restored to their proper operating condition.**

Bendix

Service Data

SD-01-503

Bendix® D-2™ Governor

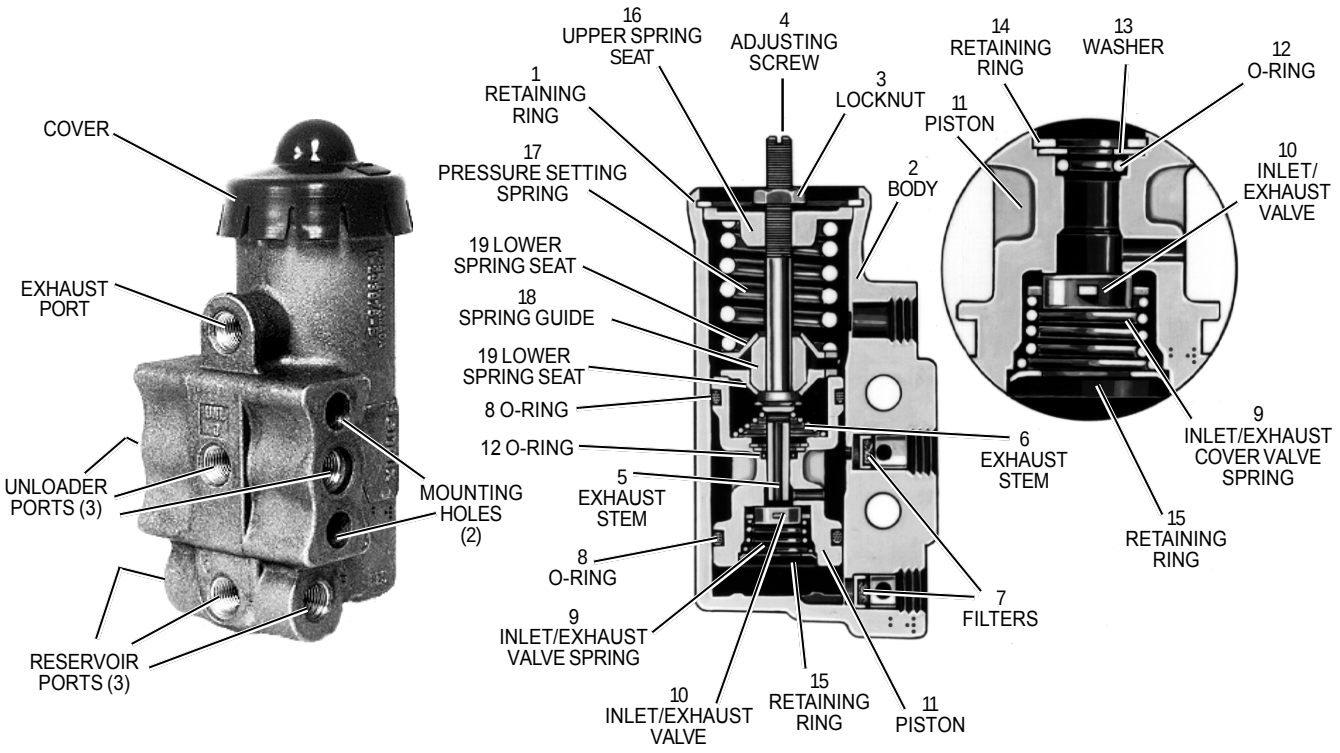


*FIGURE 1 - **D-2™ GOVERNOR***

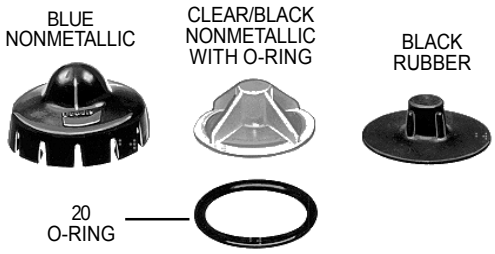


*FIGURE 2 - **TYPES OF COVERS***

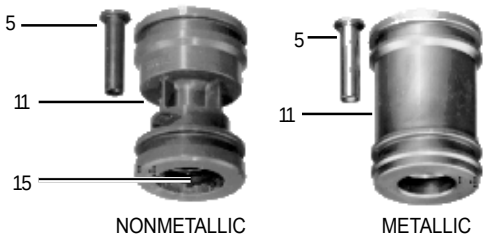


*FIGURE 3 - **TYPES OF PISTONS***

DESCRIPTION

The D-2™ governor, operating in conjunction with the unloading mechanism, automatically controls the air pressure in the air brake or air supply system between a maximum (cut-out) pressure and a minimum (cut-in) pressure. The compressor runs continually while the engine runs, but the actual compression of air is controlled by the governor actuating the compressor unloading mechanism which stops or starts the compression of air when the maximum or minimum reservoir pressures are reached.

D-2™ governors are provided with mounting holes which allow direct mounting to the compressor or remote mounting.

Porting consists of three reservoir ports (1/8 inch P.T.), three unloader ports (1/8 inch P.T.) and one exhaust port (1/8 inch P.T.).

OPERATION

Reservoir air pressure enters the D-2™ governor at one of its reservoir ports and acts on the piston and inlet/exhaust valve. As the air pressure builds up, the piston and valve move together against the resistance of the pressure setting spring. When the reservoir air pressure reaches the cut-out setting of the governor, the exhaust stem seats on the inlet/exhaust valve, closing the exhaust passage, and then opens the inlet passage. Reservoir air pressure then flows around the inlet valve, through the passage in the piston and out the unloader port to the compressor unloading mechanism. Air also flows around the piston which is slightly larger at the upper end. The added force resulting from this larger area assures a positive action and fully opens the inlet valve.

As the system reservoir air pressure drops to the cut-in setting of the governor, the force exerted by the air pressure on the piston will be reduced so that the pressure setting spring will move the piston down. The inlet valve will close and the exhaust will open. With the exhaust open, the air in the unloader line will escape back through the piston, through the exhaust stem and out the exhaust port.

PREVENTIVE MAINTENANCE

Important: Review the Bendix Warranty Policy before performing any intrusive maintenance procedures. A warranty may be voided if intrusive maintenance is performed during the warranty period.

No two vehicles operate under identical conditions, as a result, maintenance intervals may vary. Experience is a valuable guide in determining the best maintenance interval for air brake system components. At a minimum, the D-2™ governor should be inspected every 6 months or 1500 operating hours, whichever comes first, for proper operation. Should the D-2™ governor not meet the elements of the operational tests noted in this document, further investigation and service of the governor may be required.

SERVICE TESTS

OPERATING TESTS

Start the vehicle engine and build up air pressure in the air brake system and check the pressure registered by a dash or test gauge at the time the governor cuts-out, stopping the compression of air by the compressor. The cut-out pressure should be in accordance with the pressure setting of the piece number being used. (Common cut-out pressures are between 105-125 psi.) With the engine still running, make a series of brake applications to reduce the air pressure and observe at what pressure the governor cuts-in the compressor. As in the case of the cut-out pressure, the cut-in pressure should be in accordance with the pressure setting of the piece number being used. (Common cutting pressures are between 90-105 psi.)

Never condemn or adjust the governor pressure settings unless they are checked with an accurate test gauge or a dash gauge that is registering accurately. If the pressure settings of the D-2™ governor are inaccurate or it is necessary that they be changed, the adjustment procedure follows. **Note:** If the governor cover is marked nonadjustable and the adjusting stem has been sheared off, this is a nonserviceable governor and must be replaced with a new or remanufactured unit.

A. Remove the top cover from the governor.

B. Loosen the adjusting screw locknut.

C. **To raise the pressure settings,** turn the adjusting screw counter-clockwise. **To lower the pressure settings,** turn the adjusting screw clockwise. **Note:** Be careful not to overadjust. Each 1/4 turn of the adjusting screw raises or lowers the pressure setting approximately 4 psi.

D. When proper adjustment is obtained, tighten the adjusting screw locknut and replace the cover.

(**Note**: The pressure range between cut-in and cut-out is not adjustable.)

LEAKAGE TEST

Leakage tests on the D-2™ governor should be made in both cut-in and cut-out positions.

CUT-IN POSITION

Apply soap solution around the cover and to the exhaust port. Slight bubble leakage permitted. Excessive leakage indicates a faulty inlet valve or lower piston o-ring.

CUT-OUT POSITION

Apply soap solution around the cover and to the exhaust port. Slight bubble leakage permitted. Excessive leakage indicates a faulty exhaust valve seat, exhaust stem o-ring, or o-ring at the top of the piston.

If the governor does not function as described or leakage is excessive, it is recommended that it be replaced with a new or remanufactured unit, or repaired with genuine Bendix parts available at authorized Bendix parts outlets.

WARNING! PLEASE READ AND FOLLOW THESE INSTRUCTIONS TO AVOID PERSONAL INJURY OR DEATH:

When working on or around a vehicle, the following general precautions should be observed at all times.

1. **Park the vehicle on a level surface, apply the parking brakes, and always block the wheels. Always wear safety glasses.**
2. **Stop the engine and remove ignition key when working under or around the vehicle. When**

working in the engine compartment, the engine should be shut off and the ignition key should be removed. Where circumstances require that the engine be in operation, EXTREME CAUTION should be used to prevent personal injury resulting from contact with moving, rotating, leaking, heated or electrically charged components.

3. **Do not attempt to install, remove, disassemble or assemble a component until you have read and thoroughly understand the recommended procedures. Use only the proper tools and observe all precautions pertaining to use of those tools.**
4. **If the work is being performed on the vehicle's air brake system, or any auxiliary pressurized air systems, make certain to drain the air pressure from all reservoirs before beginning ANY work on the vehicle. If the vehicle is equipped with an AD-IS™ air dryer system or a dryer reservoir module, be sure to drain the purge reservoir.**
5. **Following the vehicle manufacturer's recommended procedures, deactivate the electrical system in a manner that safely removes all electrical power from the vehicle.**
6. **Never exceed manufacturer's recommended pressures.**
7. **Never connect or disconnect a hose or line containing pressure; it may whip. Never remove a component or plug unless you are certain all system pressure has been depleted.**
8. **Use only genuine Bendix® replacement parts, components and kits. Replacement hardware, tubing, hose, fittings, etc. must be of equivalent size, type and strength as original equipment and be designed specifically for such applications and systems.**
9. **Components with stripped threads or damaged parts should be replaced rather than repaired. Do not attempt repairs requiring machining or welding unless specifically stated and approved by the vehicle and component manufacturer.**
10. **Prior to returning the vehicle to service, make certain all components and systems are restored to their proper operating condition.**

REMOVING AND INSTALLING

REMOVING

1. Block and hold vehicle by means other than air brakes.
2. Drain air brake system.
3. If the governor is compressor-mounted type, disconnect reservoir air line. If the governor is remote-mounted, disconnect both the unloader and reservoir air lines.
4. Remove governor mounting bolts, then governor.

   Caution: Prior to disassembly, it is required to have the proper maintenance kit available to replace parts to be discarded during disassembly.

DISASSEMBLY

1. Clean the governor exterior of dirt and grease.
2. If the governor cover is marked nonadjustable and the adjusting screw has been sheared off, this is a nonserviceable governor and must be replaced with a new or remanufactured unit.
3. If the governor has a blue nonmetallic cover, (refer to Figure 2) hold governor with one hand, with the other hand grip cover from the top and pull up with thumb until cover disengages from the governor body. If top cover on governor is made of rubber or clear nonmetallic material unscrew cover until it releases from the adjusting screw (4) of governor. Remove o-ring (20, Figure 2) if present.
   Note: O-ring (20) is used on Hi-Temp and waterproof governors only.
4. With a pair of retaining ring pliers, remove the spring assembly retaining ring (1) and save.
5. Pull the adjusting screw (4) and spring assembly out of the governor body (2).

   Note: Disassembly of the spring assembly normally is not required. (Reuse and do not wash the assembly because lubrication may be removed.) If Disassembly of the spring assembly is necessary, the following instructions apply; otherwise, proceed to Step 6.

   Remove the lock nut (3), then the hex-shaped upper spring seat (16) from the adjusting screw (4). Remove the pressure setting spring (17), lower spring seat (19), spring guide (18) and the other lower spring seat (19) from the adjusting screw (4).
6. Gently tap the open end of the valve body on a flat surface to remove the exhaust stem (5), the exhaust stem spring (6), and piston assembly (11). Items 5 and 11 may be made of metal or nonmetallic material.
7. Remove and discard the two o-rings (8) on the piston O.D. and with a hooked wire remove and discard the o-ring (12) from the piston I.D. On nonmetallic piston, washer (13) and retaining ring (14) may be removed to facilitate removal of o-ring (12).
8. If piston assembly is nonmetallic (Figure 3), use a small screwdriver and carefully insert blade of screwdriver between two of the ears of the retainer ring in the bottom of the piston (11) and pry retainer ring (15) out of the piston and discard. Remove inlet/exhaust valve spring (9) and the inlet/exhaust valve (10) and discard. If piston assembly is metallic, disengage inlet/exhaust valve spring (9) from recess in bottom of piston (11), remove inlet/exhaust valve spring (9), and the inlet exhaust valve (10) and discard.
9. Remove and discard filters (7) from unloader and reservoir ports in governor body.

CLEANING AND INSPECTION

1. Clean all remaining parts in mineral spirits.
2. Inspect body for cracks or other damage. Be particularly careful that all air passages in the body, exhaust stem, and piston are not obstructed.
3. Check springs for cracks, distortion, or corrosion.
4. Replace all parts which are worn or damaged.

ASSEMBLY

Prior to assembly, lubricate the two lower body bores, all o-rings and o-ring grooves with lubricant provided. **Note:** Also spring guide and adjusting screw (if disassembled).

1. Install o-ring (12) in piston (11). Replace washer (13) and retaining ring (14) on nonmetallic piston if removed during disassembly.
2. Drop the inlet/exhaust valve (10) into place at the bottom of the piston (11).
3. **Nonmetallic Piston:** Install the inlet/exhaust valve spring (9) with the small end against the valve, place the retaining ring (15) on top of the large end of the valve spring (9) [concave side of retaining ring (15) facing away from piston (11)], press into piston with thumb, making sure ears of retaining ring (15) are seated into piston (11) as far as possible.

   Note: Do not use a press or hammer to install retaining ring. Excessive force may damage the piston.

   Metallic Piston: Install the inlet/exhaust valve spring (9) with the small end against the valve. Press the spring down until the larger coiled end snaps into the recess inside the piston (11).
4. Install the piston o-rings (8) on the piston (11).
5. Install the exhaust stem spring (6) in the piston (11) with the large coil end next to the piston.
6. Install the exhaust stem (5) through spring (6) and into piston (11).
7. Install assembled piston (11) into the governor body (2).
8. If the spring assembly was not disassembled, proceed to Step 9. If the spring assembly was disassembled, the following instructions apply: install on the adjusting screw (4) in this order; lower spring seat (19), spring guide (18), spring seat (19), pressure setting spring (17), hex-shaped upper spring seat (16). Screw the upper spring seat onto the adjusting screw until the distance from the top of the seat to the bottom of the adjusting screw head is approximately 1-7/8 inches. Install the lock nut (3).
9. Install the adjusting screw (4) and spring assembly into the governor body (2).
10. Install retaining ring (1) making certain that it seats completely into the groove in the governor body (2).

    If cover provided in kit is black rubber, (refer to Figure 2) install by pushing it onto the adjusting screw.

    If cover provided in kit is clear nonmetallic, install o-ring (20) and screw cover onto the adjusting screw. Tighten until cover bottoms on governor body. **Note:** O-ring (20) is used only on Hi-Temp and waterproof governors. If cover provided in kit is blue nonmetallic place cover over one edge of top of governor; with index finger catch knob on top of cover and pull until cover snaps into place.

    Note: Nonmetallic cover should be at room temperature for ease of assembly. Do not attempt to force cover on square to the governor body.
11. Install filters (7) in governor body. The head of a pencil makes a satisfactory installation tool.

INSTALLATION

1. If the governor is compressor-mounted, clean the mounting pad on both the compressor and governor. Clean connecting line, or lines. Be certain the unloading port is clear and clean. If the governor is mounted remotely, it should be positioned so that its exhaust port points down. It should be mounted higher than the compressor so that its connecting lines will drain away from the governor.
2. Install governor.
3. If compressor-mounted type, use the governor mounting gasket provided.
4. Connect air lines to governor.
5. Perform operating and leakage tests as outlined under Service Tests section.

Bendix

Service Data

SD-13-4754

Bendix® WS-20™ AntiLock Wheel Speed Sensor

DEUTSCH 2 PIN CONNECTOR

PACKARD 2 PIN CONNECTOR

STRAIGHT WS-20™ SENSOR

90° WS-20™ SENSOR

FIGURE 1 - ***WS-20™ ANTILOCK WHEEL SPEED SENSORS***

DESCRIPTION

The WS-20™ wheel speed sensor is an electromagnetic device used to obtain vehicle speed information for an antilock controller. When the wheel rotates, the sensor and an exciter (e.g. rotor or tone wheel) generate a simple AC signal. This signal is sent to the controller, which analyzes the data and commands the antilock system accordingly.

Specifically, the speed sensor consists of a coil, pole piece, and magnet. The exciter is a steel ring or gear-like device that has regularly spaced high and low spots called "teeth." The sensor is mounted in a fixed position, while the exciter is installed on a rotating member so that its "teeth" move, in close proximity, past the tip of the sensor.

The WS-20™ wheel speed sensor is available in both straight and right angle versions, to accommodate axle/wheel space limitations. (See Figure 1.)

OPERATION

The sensor's magnet and pole piece form a magnetic field. As an exciter tooth passes by the sensor, the magnetic field is altered, which generates AC voltage in the sensor coil. Each time an exciter tooth and its adjacent space move past the tip of the sensor, an AC voltage "cycle" is generated.

The number of AC cycles per revolution of the vehicle's wheel depends on the number of teeth in the exciter, which is programmed into the antilock controller. Using the programmed data, the controller can calculate "vehicle speed" by analyzing the frequency of AC cycles sent by the speed sensor. (The frequency of AC cycles is directly proportional to wheel speed.)

AC voltage is also proportional to speed, but voltage is not used to determine speed. It is only an indication of AC signal strength. The amount of AC voltage generated by a specific speed sensor depends on the distance, or "gap," between the tip of the sensor and the surface of the exciter. Voltage increases as the sensor gap decreases.

The WS-20™ wheel speed sensor is installed in a mounting block that is affixed to the axle housing. (See Figure 2.) A spring loaded retainer bushing provides a friction fit between the mounting block bore and the WS-20™ sensor. The friction fit allows the WS-20™ sensor to "slide" back and forth under force but to retain its position when force is removed. This

feature allows the WS-20™ sensor to "self adjust" after it has been installed in the mounting block and the wheel is installed.

When the WS-20™ sensor is inserted all the way into the mounting block and the wheel is installed on the axle, the hub exciter contacts the sensor, which pushes the sensor back. Also, normal bearing play will "bump" the sensor away from the exciter. The combination of these two actions will establish a running clearance or air gap between the sensor and exciter.

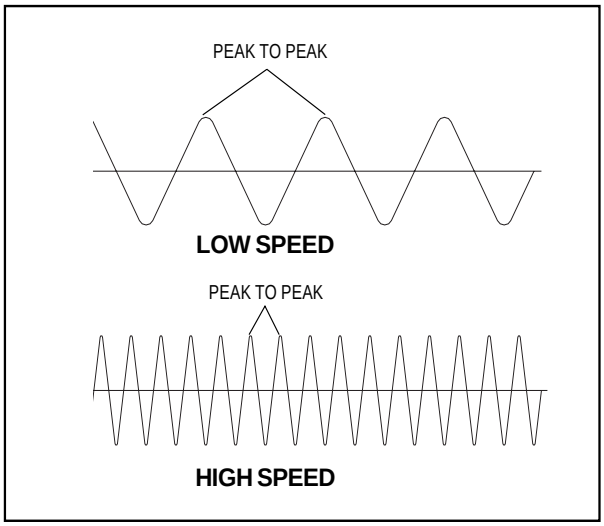


FIGURE 2 - ***SPEED SENSOR VOLTAGE CYCLE OUTPUT***

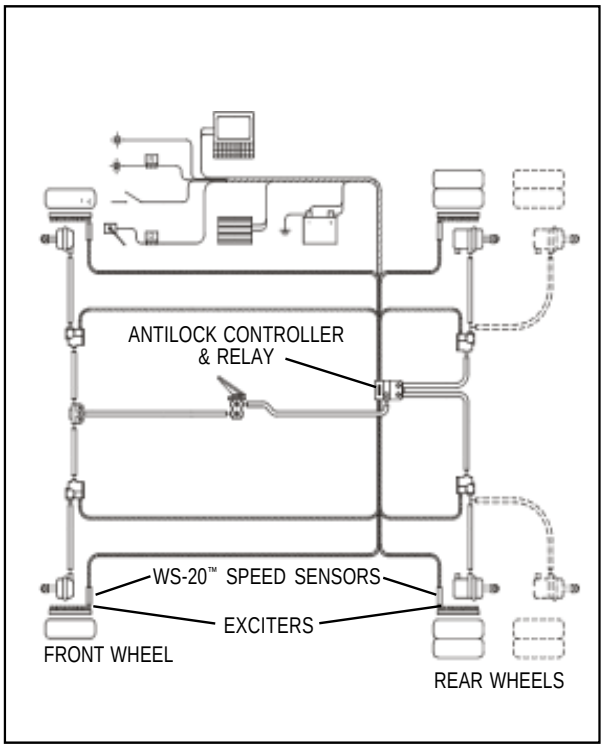


FIGURE 3 - TYPICAL ANTILOCK SYSTEM

TECHNICAL INFORMATION

Electrical Connector-	2 Pin.
Output Voltage-	With a 3,000 Ohm resistor across the two sensor leads, output voltage measured on a VOM = .800 VAC Minimum at 42 Hz, or approximately 5 mph.
Sensor Gap-	0 to .015 inch.
Sensor Body-	Formulated Epoxy; .628" Diameter.
Normal Resistance Range at Room Temp-	2000-2500 ohms

PREVENTIVE MAINTENANCE

1. Every 3 months; 25,000 miles; 900 operating hours; or during the vehicle chassis lubrication interval, make the visual inspections noted in "SERVICE CHECKS" below.
2. Every 12 months; 100,000 miles; or 3600 operating hours, perform the OPERATIONAL TEST in this manual.

SERVICE CHECKS

Check all wiring and connectors. Make sure connections are free from visible damage.

Examine the sensor. Make sure the sensor, mounting bracket, and foundation brake components are not damaged. Repair/replace as necessary.

WARNING! PLEASE READ AND FOLLOW THESE INSTRUCTIONS TO AVOID PERSONAL INJURY OR DEATH:

When working on or around a vehicle, the following general precautions should be observed at all times.

1. **Park the vehicle on a level surface, apply the parking brakes, and always block the wheels. Always wear safety glasses.**
2. **Stop the engine and remove ignition key when working under or around the vehicle. When working in the engine compartment, the engine should be shut off and the ignition key should be removed. Where circumstances require that the engine be in operation, EXTREME CAUTION should be used to prevent personal injury resulting from contact with moving, rotating, leaking, heated or electrically charged components.**
3. **Do not attempt to install, remove, disassemble or assemble a component until you have read and thoroughly understand the recommended procedures. Use only the proper tools and observe all precautions pertaining to use of those tools.**
4. **If the work is being performed on the vehicle's air brake system, or any auxiliary pressurized air systems, make certain to drain the air pressure from**

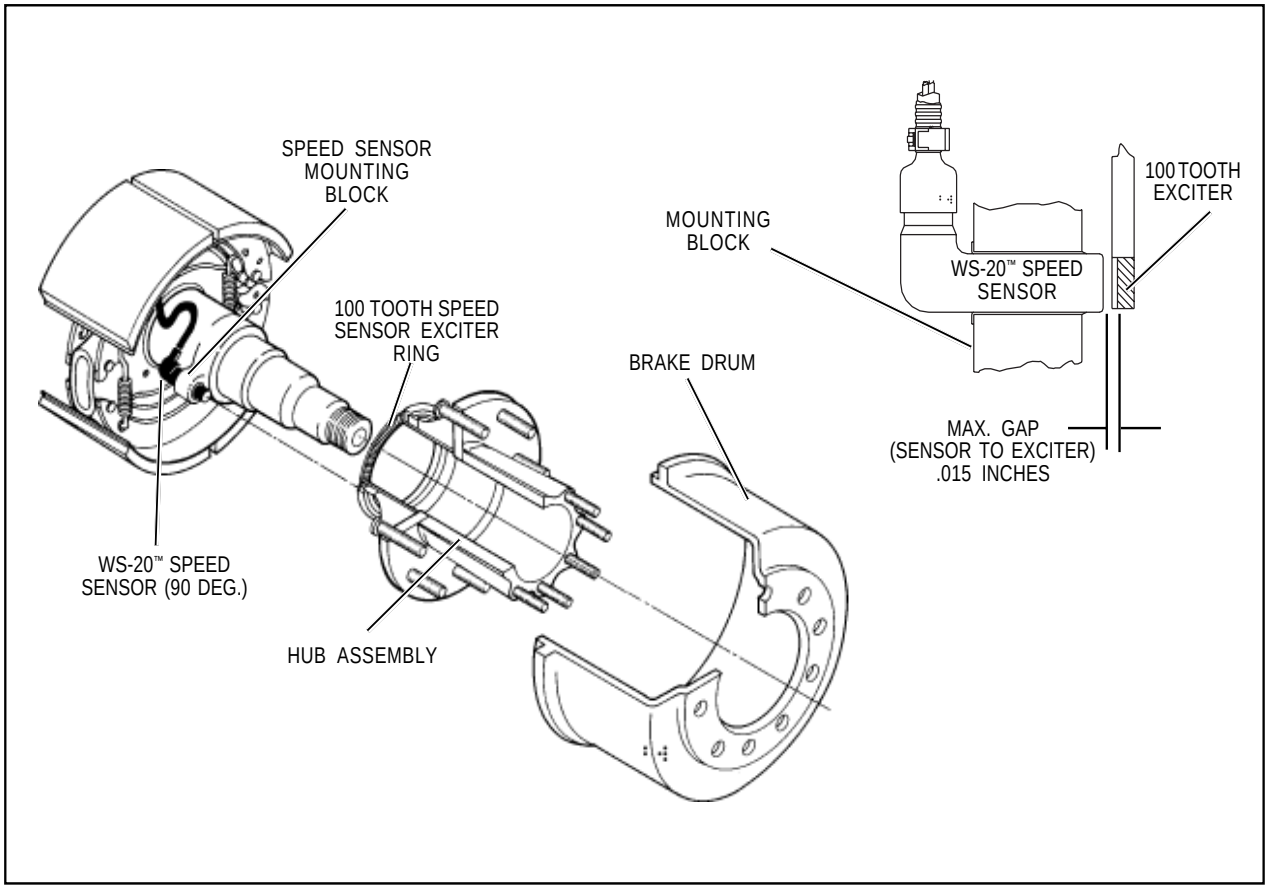


FIGURE 4 - ***WS-20™ WHEEL SPEED SENSOR INSTALLATION***

all reservoirs before beginning ANY work on the vehicle. If the vehicle is equipped with an AD-IS™ air dryer system or a dryer reservoir module, be sure to drain the purge reservoir.

5. **Following the vehicle manufacturer's recommended procedures, deactivate the electrical system in a manner that safely removes all electrical power from the vehicle.**
6. **Never exceed manufacturer's recommended pressures.**
7. **Never connect or disconnect a hose or line containing pressure; it may whip. Never remove a component or plug unless you are certain all system pressure has been depleted.**
8. **Use only genuine Bendix® replacement parts, components and kits. Replacement hardware, tubing, hose, fittings, etc. must be of equivalent size, type and strength as original equipment and be designed specifically for such applications and systems.**
9. **Components with stripped threads or damaged parts should be replaced rather than repaired. Do not attempt repairs requiring machining or welding unless specifically stated and approved by the vehicle and component manufacturer.**
10. **Prior to returning the vehicle to service, make certain all components and systems are restored to their proper operating condition.**

REMOVAL

1. Unplug the cable assembly connector from its lead. Lift the lock tab and pull on the connector until it disengages.
2. Gently pry the sensor and bushing from the mounting block.

INSPECTION

Look for any visible damage to the sensor, cable assembly, connector, mounting block, and foundation brake. Repair or replace any damaged components. Make sure the block is securely attached to the axle housing.

SENSOR INSTALLATION

1. For increased corrosion protection we recommend that a high-temperature rated silicon- or lithium-based grease be applied to the interior of the mounting block, the sensor, and to a new clamping sleeve.
2. Gently push (DO NOT STRIKE) the sensor into the mounting block hole until it bottoms out on the face of the tone ring. Secure the cable lead wire to the knuckle/axle housing 3-6 inches from the sensor.

3. Reconnect the connector to the sensor lead by plugging it into the appropriate socket on the pigtail harness, and pushing until the lock tab snaps into place.

NOTE: It is important for the wheel bearings to be adjusted per the manufacturer's recommendations, to ensure that the antilock function does not shut down as a result of excessive wheel end play.

OPERATIONAL TESTING

To test sensor operation, one of two tests can be done.

TEST 1

Drive the vehicle in a safe area to a minimum speed of 15 mph. Be sure to apply the vehicle brakes several times. Then stop the vehicle and check the LED display on the Bendix controller. If the dash light is out and the sensor LED(s) are not illuminated, the sensor is installed properly.

TEST 2

Disconnect the connector from the sensor's socket or from the attached lead. Raise the vehicle wheel so it rotates easily. Connect a volt-Ohm meter (set to read Volts AC) to the pins on the sensor or lead and spin the wheel. Output voltage should read greater than .800 AC. If the wheel is spun at 1 revolution per second (about 7mph) the reading should be greater than 1.0 volts AC.

If the sensor fails to operate as described, check the wiring from the controller to the sensor. Make sure all connectors are properly and tightly installed. Check for frayed or damaged wires and check and/or reset the sensor air gap (distance from sensor tip to exciter ring) as described in this manual. For additional troubleshooting information, see the troubleshooting procedure for the specific antilock system in use.

Operator's Manual

2005 FEBRUARY
Rev. 1 2005 SEPTEMBER
Rev. 2 2007 MARCH
OM3349EN

Allison Transmission

VOCATIONAL MODELS

Motorhome Series (MH) Transmissions

3000 and 4000 Product Families
WTEC III Controls and Allison 4th Generation Controls

3000 MH
4000 MH

Allison Transmission

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Printed in USA

NOTES

TABLE OF CONTENTS

CARE AND MAINTENANCE

DIAGNOSTICS

CUSTOMER SERVICE

TRADEMARK USAGE

The following trademarks are the property of the companies indicated:

- Allison DOC™ is a trademark of General Motors Corporation.
- DEXRON® is a registered trademark of the General Motors Corporation.
- TranSynd™ is a trademark of Castrol Ltd.

WARNINGS, CAUTIONS, NOTES

IT IS YOUR RESPONSIBILITY to be completely familiar with the warnings and cautions described in this manual. It is, however, important to understand that these warnings and cautions are not exhaustive. Allison Transmission could not possibly know, evaluate, and advise the service trade of all conceivable ways in which service might be done or of the possible hazardous consequences of each way. The vehicle manufacturer is responsible for providing information related to the operation of vehicle systems (including appropriate warnings, cautions, and notes). Consequently, Allison Transmission has not undertaken any such broad evaluation. Accordingly, **ANYONE WHO USES A SERVICE PROCEDURE OR TOOL WHICH IS NOT RECOMMENDED BY ALLISON TRANSMISSION OR THE VEHICLE MANUFACTURER MUST** first be thoroughly satisfied that neither personal safety nor equipment safety will be jeopardized by the service methods selected.

Proper service and repair is important to the safe, reliable operation of the equipment. The service procedures recommended by Allison Transmission (or the vehicle manufacturer) and described in this manual are effective methods for performing service operations. Some of these service operations require the use of tools specially designed for the purpose. The special tools should be used when and as recommended.

Three types of headings are used in this manual to attract your attention. These warnings and cautions advise of specific methods or actions that can result in personal injury, damage to the equipment, or cause the equipment to become unsafe.

WARNING: A warning is used when an operating procedure, practice, etc., if not correctly followed, could result in personal injury or loss of life.

CAUTION: A caution is used when an operating procedure, practice, etc., if not strictly observed, could result in damage to or destruction of equipment.

NOTE: A note is used when an operating procedure, practice, etc., is essential to highlight.

MOTORHOME SERIES

INTRODUCTION

KEEPING THAT ALLISON ADVANTAGE

Allison **Motorhome Series (MH) transmissions** provide many advantages for the driver who must “stop and go” or change speeds frequently. Driving is easier, safer, and more efficient.

The Motorhome Series transmissions are rugged and designed to provide long, trouble-free service. This manual will help you gain maximum benefits from your **ALLISON**-equipped vehicle.

Abbreviations

ABS	Anti-lock Brake System
CT	Closed Throttle
DOC	Diagnostic Optimized Connection
DTC	Diagnostic Trouble Code
ECM	Engine Control Module
ECU	Electronic Control Unit
EMI	Electromagnetic Interference
FCC	Federal Communications Commission
KOH	Potassium Hydroxide
J1587	Engine/transmission serial data communications link
J1939	High-speed vehicle serial data communications link
LED	Light-Emitting Diode—Electronic device used for illumination
MH	Motorhome Series
MIL	Military Specifications
OEM	Original Equipment Manufacturer
OLS	Oil Level Sensor
PC	Personal Computer—Needed to run a version of Allison DOC™ For PC–Service Tool
PD	Powered Downshift—A downshift forced by applying brakes with the throttle applied. Allison Transmission does not recommend this procedure.
PT	Part Throttle
PTO	Power Takeoff
RFI	Radio Frequency Interference
ST	Step Thru—A downshift forced by applying WOT, just prior to a CT downshift
TCM	Transmission Control Module—(also commonly referred to as the “computer” for Allison 4th Generation Controls)
TAN	Total Acid Number
TPS	Throttle Position Sensor
VIM	Vehicle Interface Module
WOT	Wide Open Throttle

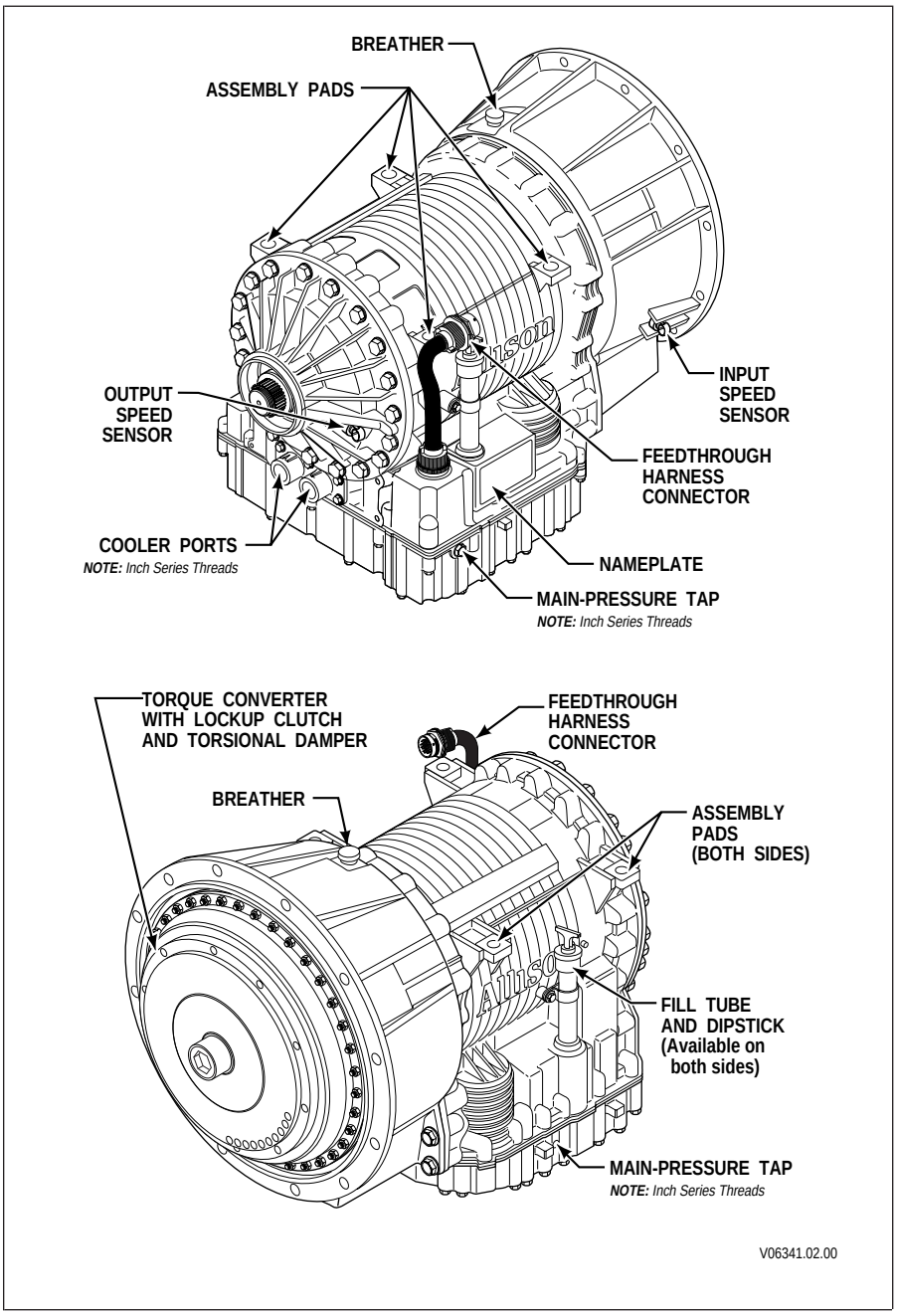


Figure 1. Typical 3000 MH Series Transmission (WTEC III Controls)

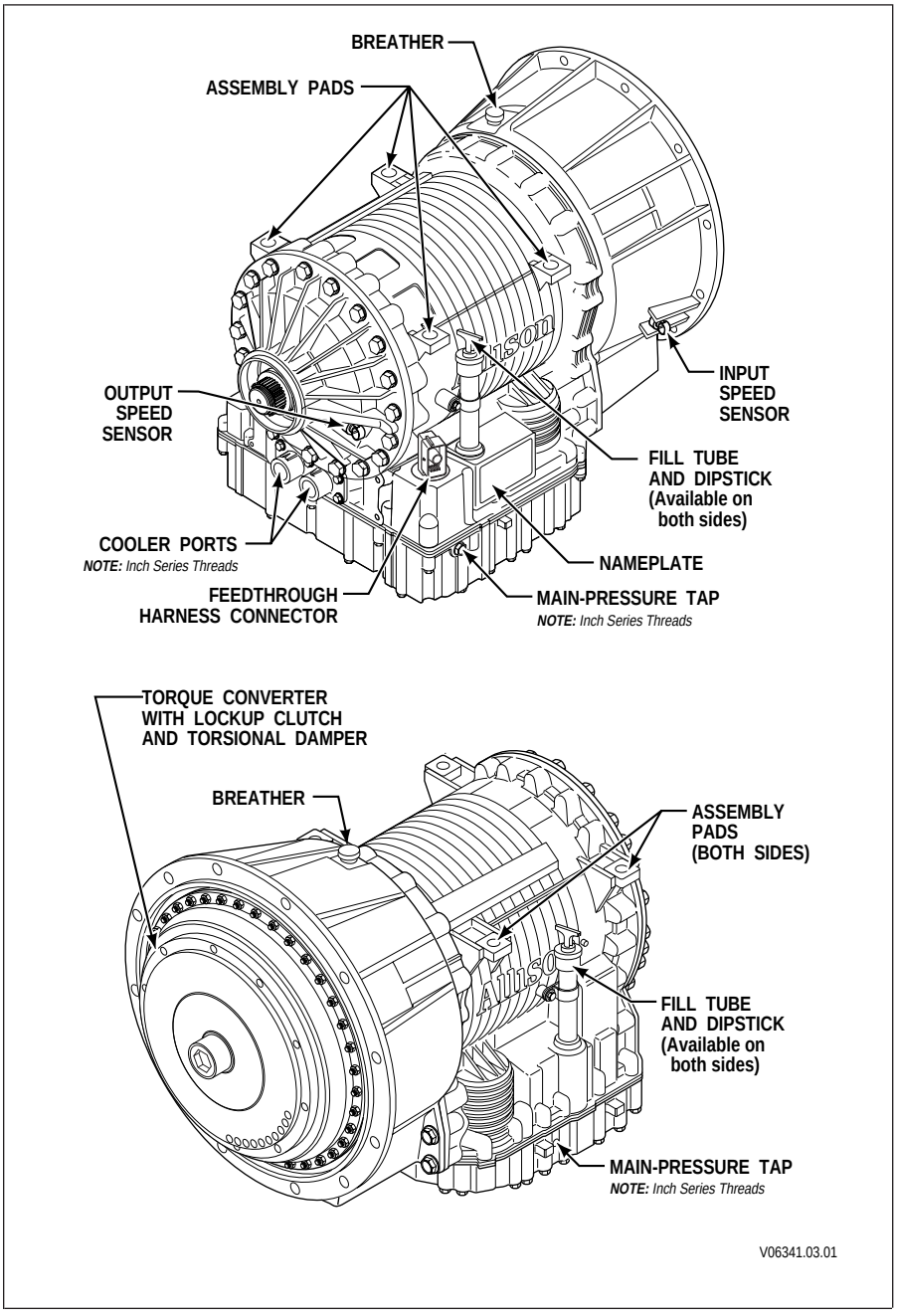


Figure 2. Typical 3000 MH Series Transmission (Allison 4th Generation Controls)

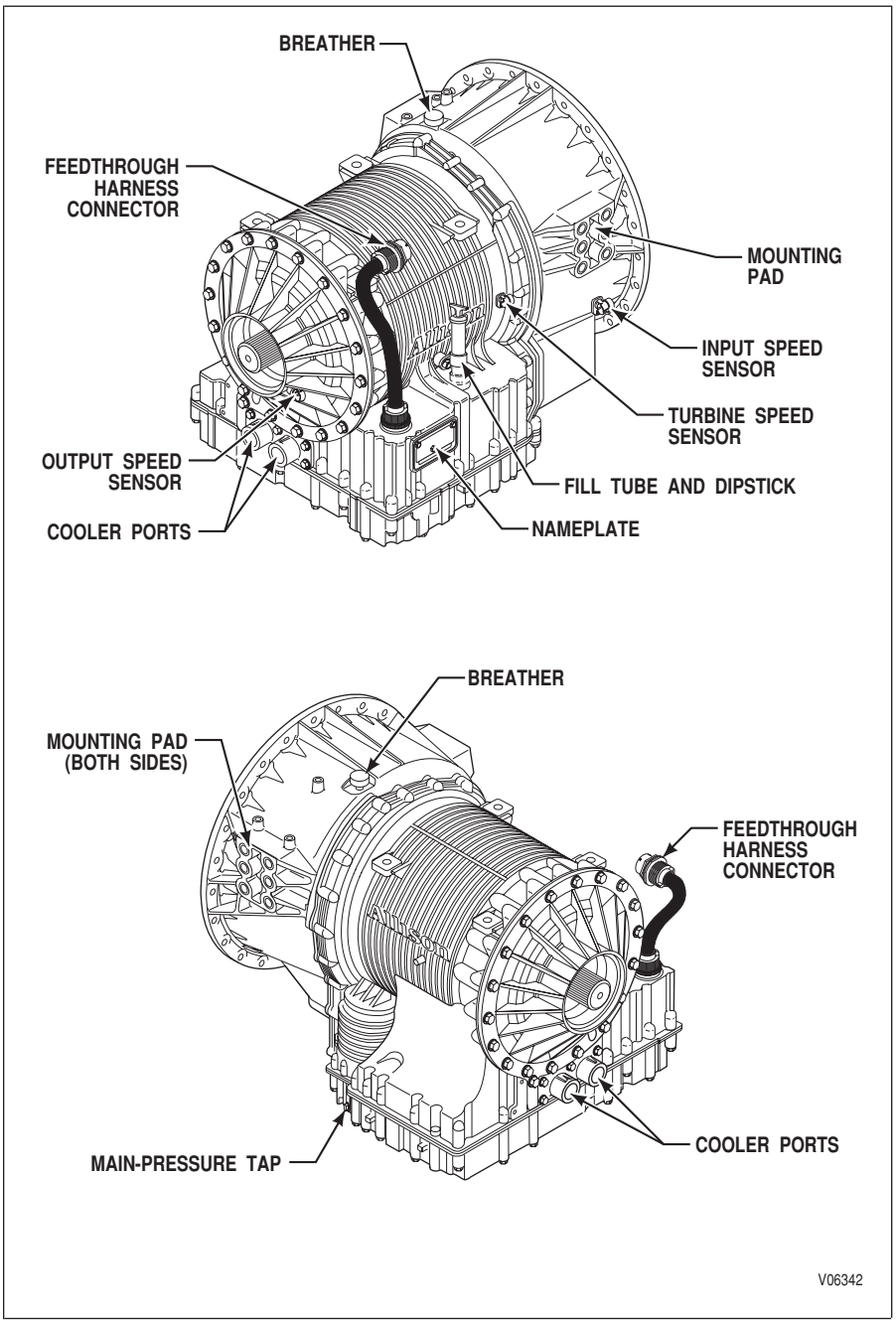


Figure 3. Typical 4000 MH Series Transmission (WTEC III Controls)

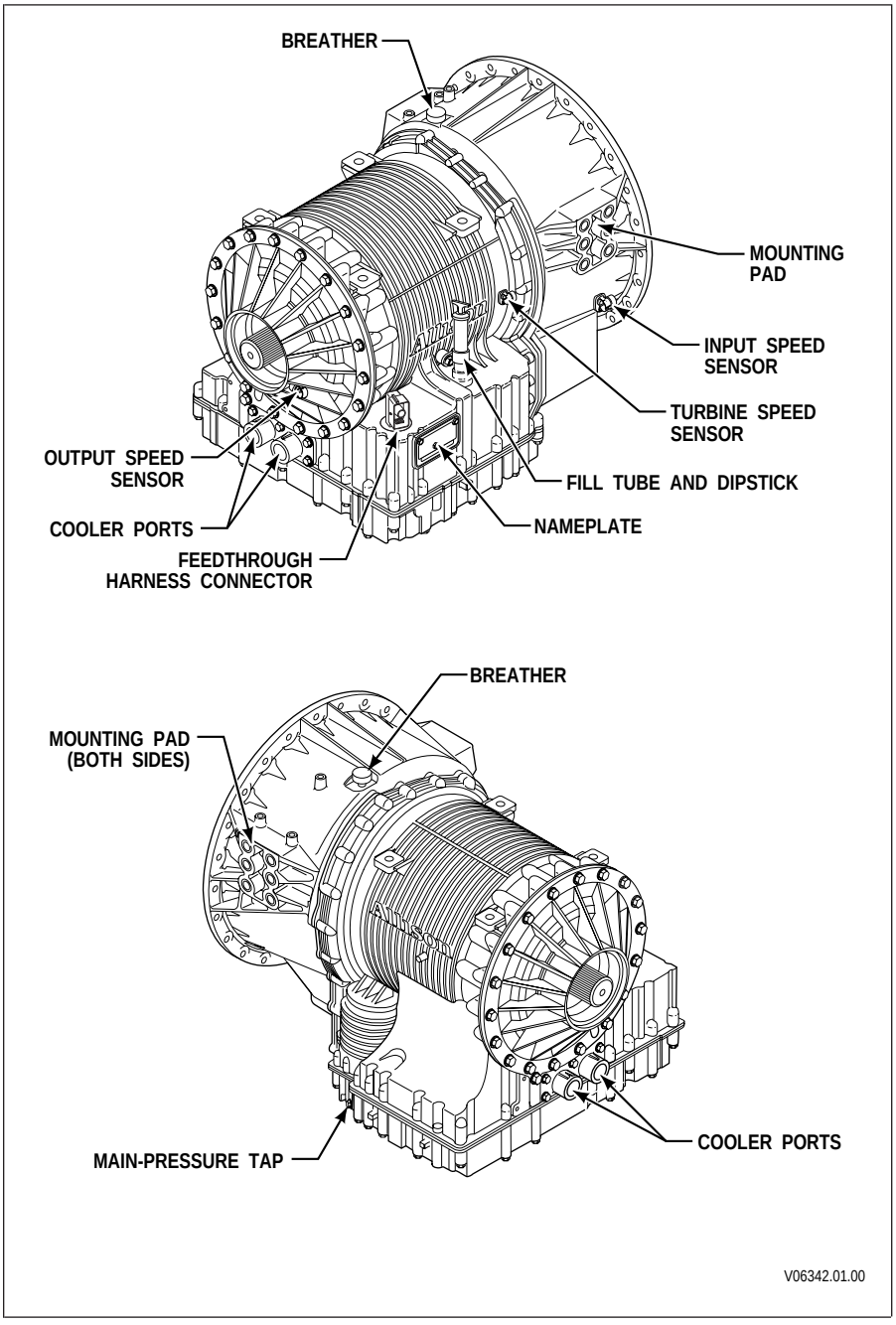


Figure 4. Typical 4000 MH Series Transmission (Allison 4th Generation Controls)

A BRIEF DESCRIPTION OF THE ALLISON MOTORHOME SERIES TRANSMISSIONS

Included in the Allison On-Highway Transmission family are the Motorhome Series transmissions. The transmissions described in this manual include:

- WTEC III Controls or Allison 4th Generation Controls
- A torque converter with lockup and torsion damper
- Three planetary gear sets

Motorhome Series transmissions may contain an integral retarder or a provision to mount a Power Takeoff (PTO).

ELECTRONIC CONTROL SYSTEM

Allison transmissions come standard with WTEC III Controls or Allison 4th Generation Controls. These systems consist of five major components connected by OEM-furnished wiring harnesses. The five major components are:

- Allison 4th Generation Transmission Control Module (TCM) or WTEC III Electronic Control Unit (ECU)
- Three speed sensors
- Remote shift selector
- Control module which contains solenoid valves, a pressure switch, and an oil level sensor (optional on WTEC III Series)
- Engine Control Module (ECM) or Engine Throttle Position Sensor (TPS), if installed

The TCM/ECU receives information from the following:

- ECM or throttle position sensor, if installed
- Speed sensors
- Pressure switch
- Shift selector

The TCM/ECU processes information and then sends signals to actuate specific solenoids located in the control valve module. These solenoids control both oncoming and off-going clutch pressures to provide closed-loop shift control by matching input rpm during a shift to a desired profile programmed into the TCM/ECU.

A feature of both Allison 4th Generation Controls and WTEC III Controls is "autodetect." Autodetect is active within the first several engine starts, depending upon the component or sensor being detected. These engine start cycles begin when the transmission is installed during vehicle manufacture. Autodetect searches for the presence of the following transmission components or data inputs:

Transmission Components

Retarder	Present, Not Present
Oil Level Sensor (OLS)	Present, Not Present
Throttle	Analog, J1587, J1939
Engine Coolant Temperature	Analog, J1939, J1587

Seek help from the nearest Allison Transmission service outlet when any of the above components are present, but are not responding properly.

Another feature of the Allison transmission is its ability to adapt or "learn" as it operates. Each shift is measured electronically, stored, and used by the TCM/ECU to adapt or "learn" the optimum control for future shifts.

NOTE: Allison 4th Generation Controls and WTEC III Controls are designed and manufactured to comply with all FCC and other guidelines regarding radio frequency interference/electromagnetic interference (RFI/EMI) for transportation electronics. Manufacturers, assemblers, and installers of radio-telephone or other two-way communication radios have the sole responsibility to correctly install and integrate those devices into Allison transmission-equipped vehicles to customer satisfaction.

The TCM/ECU is programmed to provide the most suitable operating characteristics for a specific application. This manual does not attempt to describe all of the possible combinations. The information contained herein describes only the operating characteristics most frequently requested by the vehicle manufacturer.

TORQUE CONVERTER

The torque converter consists of the following four elements:

- Pump—input element driven directly by the engine
- Turbine—output element hydraulically driven by the pump
- Stator—reaction (torque multiplying) element
- Lockup Clutch—mechanically couples the pump and turbine when engaged; controlled by TCM/ECU

When the pump turns faster than the turbine, the torque converter is multiplying torque. When the turbine approaches the speed of the pump, the stator starts to rotate with the pump and turbine. When this occurs, torque multiplication stops and the torque converter functions as a fluid coupling.

The lockup clutch is located inside the torque converter and consists of the following elements:

- Piston and backplate—driven by the engine
- Clutch plate/damper (located between the piston and the backplate)—splined to the converter turbine

The lockup clutch/torsional damper is engaged and released in response to electronic signals from the TCM/ECU. Lockup clutch engagement provides a direct drive from the engine to the transmission gearing. This eliminates converter slippage and maximizes fuel economy and vehicle speed. The lockup clutch releases at lower speeds or when the TCM/ECU detects conditions requiring it to be released.

The torsional damper absorbs engine torsional vibration to prevent transmitting vibrations through the powertrain.

PLANETARY GEARS AND CLUTCHES

A series of three helical planetary gear sets and shafts provides the mechanical gear ratios and direction of travel for the vehicle. The planetary gear sets are controlled by five multiplate clutches that work in pairs to produce up to six forward speeds and one reverse speed. The clutches are applied and released hydraulically in response to electronic signals from the TCM/ECU to the appropriate solenoids.

COOLER CIRCUIT

The transmission fluid is cooled by an integral (transmission-mounted) or remote-mounted oil cooler. Connections to the cooling circuit are located at the front or rear of the transmission to facilitate installation of remote cooler lines. On retarder models, only the rear cooler ports may be used. The integral cooler is mounted on the lower rear portion of the transmission, replacing the remote cooler manifold. Integral cooler oil ports are internal requiring coolant to be routed to and from the cooler.

A new feature has been added on all retarder-equipped transmissions. The retarder housing now allows addition of either a remote or integral cooler for transmission sump fluid in addition to retarder out fluid. A by-pass cover is placed over the sump cooling ports when the provision is not used. The sump cooler ports are located on the lower right rear face of the retarder housing (refer to Figure 1 through Figure 4).

RETARDER

The self-contained retarder is at the output of the transmission and consists of a vaned rotor which rotates in a vaned cavity. The rotor is splined to and driven by the output shaft. An external accumulator holds transmission fluid until the retarder is activated. When the retarder is activated, the fluid in the accumulator is forced by the vehicle air system into the retarder cavity. The pressurized fluid in the cavity acting against the rotating and stationary vanes causes the retarder rotor and output shaft to reduce speed, slowing the vehicle or limiting speed on a downhill grade. Refer to USING THE HYDRAULIC RETARDER for additional information.

When the retarder is deactivated, the retarder cavity is evacuated and the accumulator is recharged with fluid.

MOTORHOME SERIES

SHIFT SELECTORS

DESCRIPTION OF AVAILABLE TYPES

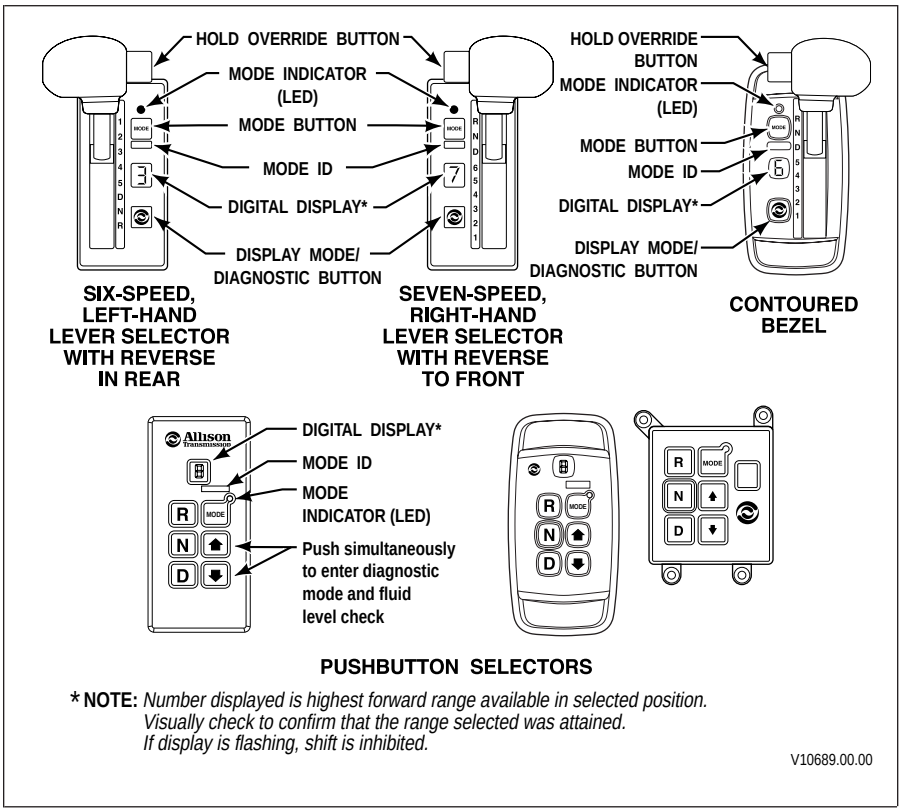


Figure 5. WTEC III Shift Selectors

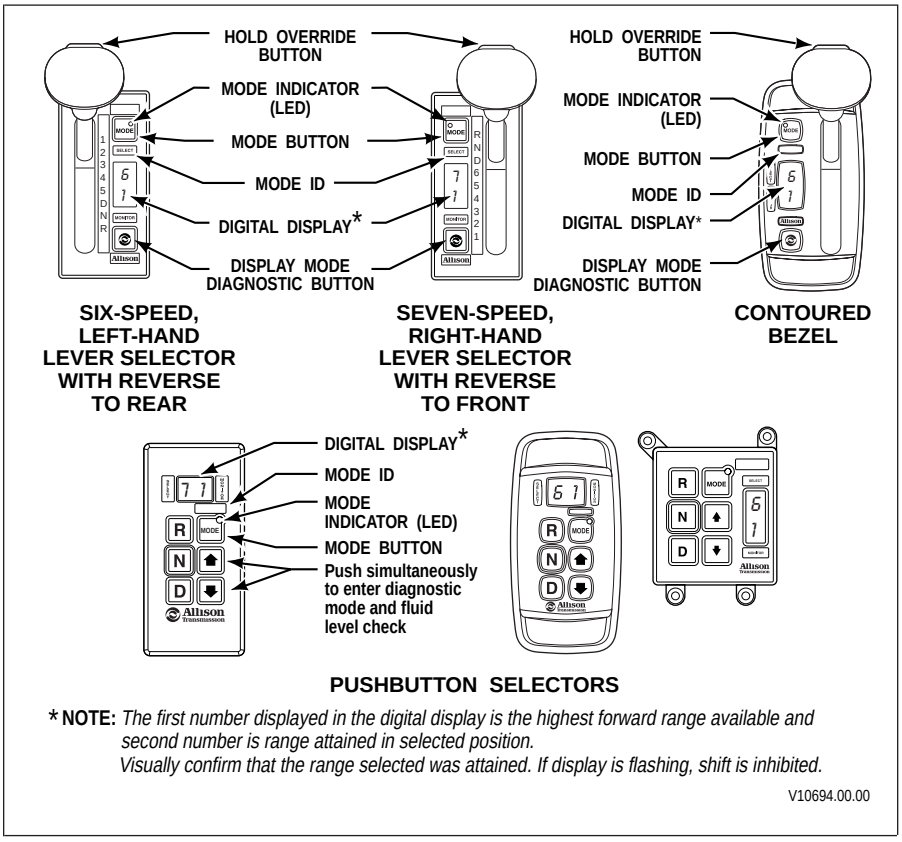


Figure 6. Allison 4th Generation Controls Shift Selectors

INTRODUCTION

Vehicle manufacturers may choose different types of shift selectors for their vehicles. The shift selector in your Allison-equipped vehicle will be similar to one of the pushbutton or lever styles shown above.

With an Allison-equipped vehicle, it is not necessary to select the right moment to upshift or downshift during changing road and traffic conditions. The Allison transmission does it for you. However, knowledge of the shift selector positions, available ranges, and when to select them, make vehicle control and your job even easier. Select lower ranges when descending long grades (with or without retarder) to reduce wear on service brakes. Refer to the Range Selection table at the end of this section for related information.

LEVER SHIFT SELECTOR

General Description. The lever shift selector (refer to Figure 5 and Figure 6) is an electro-mechanical control. Typical lever positions are:

- **R** (Reverse)
- **N** (Neutral)
- **D** (Drive)
- Some number of lower forward range positions

Motorhome Series transmissions can be programmed to have four, five, or six forward ranges. Shift selector positions should agree with the programming of the TCM/ECU unit.

The lever selector includes the following:

- **HOLD OVERRIDE** button
- **MODE** button
- Digital display
- **DISPLAY MODE/DIAGNOSTIC** button

HOLD OVERRIDE Button. The lever shift selector has three locked positions to prevent accidentally selecting **R** (Reverse), **N** (Neutral), or **D** (Drive). Select **R** (Reverse), **N** (Neutral), or **D** (Drive) by pressing the **HOLD OVERRIDE** button and moving the lever to the desired position. Once **D** (Drive) is selected, lower forward range positions may be selected without pressing the **HOLD OVERRIDE** button.

MODE Button. The **MODE** button can allow the driver to enable a secondary shift schedule, PTO enable, or other special functions that have been programmed into the TCM/ECU unit at the request of the OEM. For example, a vehicle OEM may have provided a secondary shift schedule for improved fuel economy. The name of the special function (ECONOMY) appears on the MODE ID label adjacent to the **MODE** button. Pressing the **MODE** button activates the ECONOMY shift schedule and illuminates the MODE INDICATOR (LED).

When the Diagnostic Display Mode has been entered, the **MODE** button is used to view and toggle through diagnostic code information. After viewing the first diagnostic code which appears in the digital display, press the **MODE** button to view the 2nd diagnostic code logged. Repeat this procedure to view the 3rd, 4th, and 5th code positions. The code displayed is active if the MODE INDICATOR (LED) is illuminated.

NOTE: Visually check the digital display whenever the lever is moved. **N** should appear in the digital display if the **N** (Neutral) button is pressed.

Digital Display. During normal operation, if **D** (Drive) is selected, the digital display shows the highest forward range attainable for the shift schedule in use.

Abnormal operation is indicated by the WTEC III digital display as follows:

- When all segments of the digital display are illuminated for more than 12 seconds, the ECU did not complete initialization.
- When the digital display is blank, there is no power to the selector.
- When the display shows a "/\" (cateye), a selector-related fault code has been logged.
- Conditions which illuminate the **CHECK TRANS** light disable the shift selector and the digital display displays the range actually attained. For a detailed explanation, refer to the CHECK TRANS LIGHT paragraph in the DRIVING TIPS section.

Abnormal operation is indicated by the Allison 4th Generation Controls digital display as follows:

- When all segments of the digital display are illuminated, the shift selector did not complete initialization.
- When both digital displays remain blank for 10 seconds after initialization and then show a "/\" (cateye), the shift selector is unable to communicate with the TCM or has experienced an internal fault.
- When the display shows a "/\" (cateye), a selector-related fault code has been logged.
- Conditions which illuminate the **CHECK TRANS** light disable the shift selector. The SELECT digit is blank and the MONITOR digit displays the range actually attained. For a detailed explanation, refer to the CHECK TRANS LIGHT paragraph in the DRIVING TIPS section.

The transmission will not shift into range if a **CHECK TRANS** code is active. When the display shows **R** or **D** has been requested and the display is flashing, the requested range has not been achieved due to an inhibit function.

Some inhibit functions are vehicle-related and do not result in diagnostic codes. Some examples are mentioned in the Range Selection tables at the end of this section.

Check for active codes if no other inhibit function has been located. Once **D** (Drive) is attained, the transmission will shift into the lowest range programmed for the **D** (Drive) position, usually first-range.

Display Mode/Diagnostic Button. The **DISPLAY MODE/DIAGNOSTIC** button allows access to fluid level check information and diagnostic code information. Press the **DISPLAY MODE/DIAGNOSTIC** button once to obtain transmission fluid level information and a second time to obtain diagnostic code information.

PUSHBUTTON SHIFT SELECTOR

General Description. The pushbutton shift selector (refer to Figure 5 and Figure 6) has the following:

- **R** (Reverse)—Press this button to select Reverse.
- **N** (Neutral)—Press this button to select Neutral.
- **D** (Drive)—Press this button to select Drive. The highest forward range available will appear in the digital display window. The transmission will start out in the lowest available forward range and advance automatically to the highest range.
- ↑ **(Up) Arrow**—Press the ↑ (Up) Arrow when in **DRIVE** to request the next higher range. Continuously pressing the ↑ (Up) Arrow will request the highest range available.
- ↓ **(Down) Arrow**—Press the ↓ (Down) Arrow when in **DRIVE** to request the next lower range. Continuously pressing the ↓ (Down) Arrow will request the lowest range available.
- **MODE Button and Display Mode/Diagnostic Button**—This is the same function as described previously in the LEVER SHIFT SELECTOR paragraph, **MODE Button** paragraph.

NOTE: The oil level sensor (OLS) is an optional feature on WTEC III transmissions. The OLS is a standard feature on all Allison 4th Generation transmissions except 3000 Product Family 7-speed transmissions. Fluid level information is displayed after pressing both the ↑ (Up) and ↓ (Down) arrow buttons simultaneously. Simultaneously press both buttons again to obtain diagnostic data.

Refer to the Care And Maintenance section, FLUID LEVEL CHECK USING PUSHBUTTON OR LEVER SHIFT SELECTOR, for more information about fluid level data. Refer to the Driving Tips section, DIAGNOSTIC CODES and DIAGNOSTIC CODE DISPLAY PROCEDURE, for more information about diagnostic codes and display procedure.

RANGE SELECTION

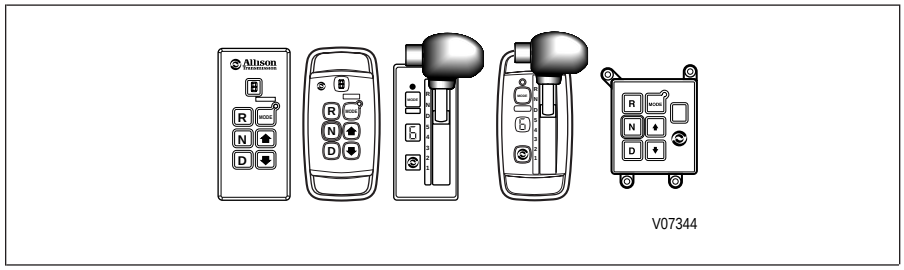


Figure 7. Typical Shift Selectors (WTEC III Controls)

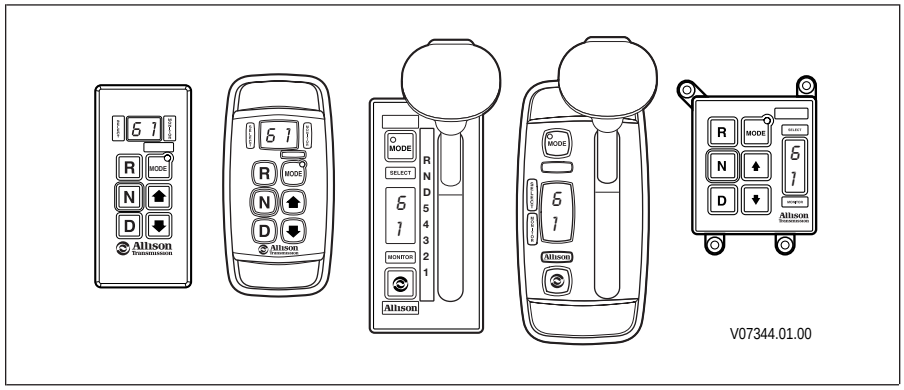


Figure 8. Typical Shift Selectors (Allison 4th Generation Controls)

PUSHBUTTON AND LEVER SHIFT SELECTORS WITH DIGITAL DISPLAY

Description of Available Ranges (refer to Figure 7 and Figure 8)	
	**WARNING:** If you leave the vehicle and the engine is running, the vehicle can move unexpectedly and you or others could be injured. If you must leave the engine running, do not leave the vehicle until you have completed all of the following procedures: 1. Put the transmission in **N** (Neutral). 2. Be sure the engine is at low idle (500–800 rpm). 3. Apply the parking brakes and emergency brake and make sure they are properly engaged. 4. Chock the wheels and take any other steps necessary to keep the vehicle from moving.
	**WARNING: R** (Reverse) may not be attained due to an active inhibitor. Always apply the service brakes when selecting **R** (Reverse) to prevent unexpected vehicle movement and because a service brake inhibit may be present. When **"R"** is flashing, it indicates the shift to **R** (Reverse) is inhibited. Check for active diagnostic codes if **R** (Reverse) is not attained. See DOWNSHIFT AND DIRECTION CHANGE INHIBITOR FEATURE in the DRIVING TIPS section.
	**CAUTION:** Do not idle in **R** (Reverse) for more than five minutes. Extended idling in **R** (Reverse) can cause transmission overheating and damage. Always select **N** (Neutral) whenever time at idle exceeds five minutes.
	**NOTE:** Visually check the digital display window whenever a button is pushed or the lever is moved to be sure the range selected is shown (i.e., if the **N** (Neutral) button is pressed, **"N"** should appear in the digital display). A flashing display indicates the range selected was not attained due to an active inhibit.

PUSHBUTTON AND LEVER SHIFT SELECTORS WITH DIGITAL DISPLAY *(cont'd)*

Description of Available Ranges (refer to Figure 7 and Figure 8)	
R	Completely stop the vehicle and let the engine return to idle before shifting from a forward range to **R** (Reverse) or from **R** (Reverse) to a forward range. The digital display will display **"R"** when **R** (Reverse) is selected.
	**WARNING:** When starting the engine, make sure the service brakes are applied. Failure to apply the service brakes can result in unexpected vehicle movement.
	**WARNING:** Vehicle service brakes, parking brake, or emergency brake must be applied whenever **N** (Neutral) is selected to prevent unexpected vehicle movement. Selecting **N** (Neutral) does not apply vehicle brakes, unless an auxiliary system to apply the parking brake is installed (see the Operator's Manual for the vehicle).
	**WARNING:** If you let the vehicle coast in **N** (Neutral), there is no engine braking and you could lose control. Coasting can also cause severe transmission damage. To help avoid injury and property damage, do not allow the vehicle to coast in **N** (Neutral).
N	Use **N** (Neutral) when starting the engine, to check vehicle accessories, and for extended periods of engine idle operation (longer than five minutes). For vehicles equipped with the pushbutton selector, **N** (Neutral) is selected by the TCM/ECU during start-up. For vehicles equipped with the lever selector, the vehicle will not start unless **N** (Neutral) has been selected. If the vehicle starts in any range other than **N** (Neutral), seek service immediately. **N** (Neutral) is also used during stationary operation of the power takeoff (if the vehicle is equipped with a PTO). The digital display will show **"N"** when **N** (Neutral) is selected. Always select **N** (Neutral) before turning off the vehicle engine.

PUSHBUTTON AND LEVER SHIFT SELECTORS WITH DIGITAL DISPLAY *(cont'd)*

Description of Available Ranges (refer to Figure 7 and Figure 8)	
	**WARNING: D** (Drive) may not be attained due to an active inhibitor. Always apply the service brakes when selecting **D** (Drive) to prevent unexpected vehicle movement and because a service inhibit may be present. When **"D"** is flashing, it indicates the shift to **D** (Drive) is inhibited. Check for active diagnostic codes if **D** (Drive) is not attained. See DOWNSHIFT AND DIRECTION CHANGE INHIBITOR FEATURE in the DRIVING TIPS section.
	**CAUTION:** Do not idle in **D** (Drive) or any forward range for more than five minutes. Extended idling in **D** (Drive) can cause transmission overheating and damage. Always select **N** (Neutral) whenever time at idle exceeds five minutes.
	**NOTE:** Turn off the vehicle HIGH IDLE switch, if present, before shifting from **N** (Neutral) to **D** (Drive) or **R** (Reverse). **D** (Drive) or **R** (Reverse) will not be attained unless the shift is made with the engine at idle. Also, be aware of other interlocks that would prevent attaining **D** (Drive) or **R** (Reverse). Examples are "wheelchair lift not stored" and "service brakes not applied" (service brake interlock present).
D	The transmission will initially attain first-range when **D** (Drive) is selected (except for those units programmed to start in second-range). As vehicle speed increases, the transmission will upshift automatically through each range. As the vehicle slows, the transmission will downshift automatically through each range. The digital display will show the highest range available in **D** (Drive).
	**WARNING:** The transmission incorporates a hold feature to prohibit upshifting above the range selected during normal driving. For downhill operation, select a lower transmission range. If the engine governed speed is exceeded in the held range, however, the transmission will upshift to the next higher range to prevent engine damage. To avoid injury and/or property damage due to loss of vehicle control, use the vehicle brakes to prevent exceeding engine governed speed in the held range.

PUSHBUTTON AND LEVER SHIFT SELECTORS WITH DIGITAL DISPLAY *(cont'd)*

Description of Available Ranges (refer to Figure 7 and Figure 8)	
6* 5* 4* 3 2	Lower ranges provide greater engine braking for going down grades (the lower the range, the greater the braking effect). Occasionally, it may be desirable to restrict automatic shifting to a lower range because of: • Road conditions. • Load. • Traffic conditions. • Etc. The pushbutton shift selector arrow buttons access individual forward ranges. Push the ↑ (Up) or ↓ (Down) arrow for the desired range. The digital display shows the range chosen. Even though a lower range is selected, the **transmission may not downshift** until vehicle speed is reduced (this prevents excessive engine speed in the lower range).
1	First-range provides the vehicle with its maximum driving torque and engine braking effect. Use first-range when: • Pulling through mud and deep snow. • Maneuvering in tight spaces. • Driving up or down steep grades. For vehicles equipped with the pushbutton selector, push the ↓ (Down) arrow until first-range appears in the select window.
* Actual ranges available depend on programming by vehicle manufacturer.	

MOTORHOME SERIES

DRIVING TIPS

CHECK TRANS LIGHT

The electronic control system is programmed to inform the operator of a problem with the transmission system and automatically take action to protect the operator, vehicle, and transmission. When the Electronic Control Unit (ECU) or the Transmission Control Module (TCM) detects a problem condition, the TCM/ECU:

- Restricts shifting.
- Illuminates the **CHECK TRANS** light on the instrument panel.
- Registers a diagnostic code.

NOTE: For some problems, diagnostic codes may be registered without the TCM/ECU activating the **CHECK TRANS** light. Your Allison Transmission authorized service outlet should be consulted whenever there is a transmission-related concern. They have the equipment to check for diagnostic codes and to correct problems which arise.

Each time the engine is started, the **CHECK TRANS** light will illuminate, then turn off after a few seconds. This momentary lighting is to show that the status light circuits are working properly. If the **CHECK TRANS** light does not illuminate during ignition, or if the light remains on after ignition, the system should be checked immediately.

Continued illumination of the **CHECK TRANS** light during vehicle operation (other than start-up) indicates that the TCM/ECU has signaled a diagnostic code. Illumination of the **CHECK TRANS** light is accompanied by a flashing display from the shift selector. The shift selector display will show the actual range attained and the transmission will not respond to shift selector requests.

Indications from the shift selector are provided to inform the operator the transmission is not performing as designed and is operating in the “limp home” mode with reduced capabilities. Before turning off the ignition, the transmission may be operated for a short time in the selected range in order to “limp home” for

service assistance. Service should be performed immediately in order to minimize the potential for damage to the transmission.

When the **CHECK TRANS** light comes on and the ignition switch is turned off, the transmission will remain in **N** (Neutral) until the condition causing the **CHECK TRANS** light is corrected.

Generally, while the **CHECK TRANS** light is on, upshifts and downshifts will be restricted and **direction changes will not occur**. Lever and pushbutton shift selectors **do not respond** to any operator shift requests while the **CHECK TRANS** light is illuminated. The lockup clutch is disengaged when transmission shifting is restricted or during any critical transmission malfunction.

DIAGNOSTIC CODES

Diagnostic Codes Overview. Refer to detailed information in the DIAGNOSTICS section.

ACCELERATOR CONTROL

WARNING: To help avoid injury or property damage caused by sudden movement of the vehicle, do not make shifts from **N** (Neutral) to **D** (Drive) or **R** (Reverse) when the throttle pedal is depressed. If you shift while the throttle pedal is depressed too far, the transmission will only engage if the throttle pedal is released in the next three seconds. This may cause a sudden movement of the vehicle. Leaving the throttle pedal depressed longer than three seconds causes the transmission to remain in **N** (Neutral). Avoid this condition by making shifts from **N** (Neutral) to **D** (Drive) or **R** (Reverse) only when the throttle is closed.

The position of the accelerator pedal influences when automatic shifting occurs. An electronic throttle position signal tells the TCM/ECU how much the operator has depressed the pedal. When the pedal is fully depressed, upshifts will occur automatically at high engine speeds. A partially depressed position of the pedal will cause upshifts to occur at lower engine speeds. Excessive throttle position affects directional changes—shifts from **N** (Neutral) to **D** (Drive) or **R** (Reverse).

DOWNSHIFT AND DIRECTION CHANGE INHIBITOR FEATURE

NOTE: Turn off the vehicle HIGH IDLE switch, if present, before shifting from **N** (Neutral) to **D** (Drive) or **R** (Reverse). The shift from **N** (Neutral) to **D** (Drive) or **R** (Reverse) is inhibited when engine speed is above idle.

There is no speed limitation on upshifting, but there is a limitation on downshifting and for shifts that cause a direction change such as **D** (Drive)-to-**R** (Reverse) or **R** (Reverse)-to-**D** (Drive).

Manual range downshifts will not occur until a calibration output speed (preset) is reached. When a range downshift is manually selected and the transmission output speed is above the calibration speed, the transmission will stay in the range it was in even though a lower range was requested. Apply the vehicle service brakes or a retarding device to reduce the transmission output speed to the calibration speed and then the shift to the lower range will occur.

Directional shifts, **D** (Drive)-to-**R** (Reverse) or **R** (Reverse)-to-**D** (Drive), will not occur if selected when throttle position, engine speed, or transmission output speed is above the calibration limit for a calibration time period. The current calibration time period for engine speed is 0.5 seconds and for throttle position and output speed is three seconds.

Shifts from **N** (Neutral)-to-**D** (Drive) or **N** (Neutral)-to-**R** (Reverse) are also inhibited when the TCM/ECU has been programmed (by input/output function) to detect that auxiliary equipment is in operation and the shift should not be allowed.

When directional change shifts are inhibited, the TCM/ECU will put the transmission in **N** (Neutral) and the digital display, if present, will flash the letter of the range selected (D or R). To reselect **D** (Drive) or **R** (Reverse) when engine throttle, engine speed, and transmission output speed are below the calibration value:

- Pushbutton selector—Press the desired pushbutton again.
- Lever selector—Move the lever to **N** (Neutral) and then to the desired range.

When a direction change shift is requested and engine throttle, engine speed, and transmission output speed drop below the calibration value during the calibration time interval, the shift to **D** (Drive) or **R** (Reverse) will occur.

For example, if the transmission output speed was just above the calibration limit when **R** (Reverse) was selected, but dropped below the limit during the next three seconds, the shift to **R** (Reverse) would occur (assuming the engine was at idle and the throttle was closed).

USING THE ENGINE TO SLOW THE VEHICLE

WARNING: To avoid loss of control, use a combination of downshifting, braking, and other retarding devices. Downshifting to a lower transmission range increases engine braking and can help you maintain control. The transmission has a feature to prevent automatic upshifting above the lower range selected. However, during downhill operation, if engine governed speed is exceeded in the lower range, the transmission will upshift to the next higher range to prevent engine damage. This will reduce engine braking and could cause a loss of control. Apply the vehicle brakes or other retarding device to prevent exceeding engine governed speed in the lower range selected.

Engine braking provides good speed control for going down grades. When the vehicle is heavily loaded, or the grade is steep, it may be desirable to preselect a lower range before reaching the grade. If engine-governed speed is exceeded, the transmission will upshift automatically to the next range.

To use the engine as a braking force, select the next lower range. If the vehicle is exceeding the maximum speed for this range, use the service brakes and/or retarder to slow the vehicle. When a lower speed is reached, the TCM/ECU will automatically downshift the transmission.

USING THE HYDRAULIC RETARDER

WARNING: DO NOT USE THE RETARDER DURING INCLEMENT WEATHER OR WHEN ROAD SURFACES ARE SLIPPERY. De-energize the retarder at the master control switch.

To help avoid injury or property damage caused by loss of vehicle control, be ready to apply vehicle brakes or other retarding device if the transmission retarder does not apply. If a retarder is present but is not detected by “autodetect”, the retarder will not function. Be sure to check for proper retarder function periodically. Whenever the retarder does not apply, seek service help immediately.

On vehicles which have the primary retarder control based upon closed throttle position, brake pedal position, or brake apply pressure, always manually disable the retarder controls during inclement weather or slippery road conditions.

Regardless of the type of Allison retarder controls on your vehicle, the following safety features are common to each configuration:

- The retarder can be disabled when inclement weather or slippery road conditions are present.

- Vehicle brake lights should always be on when the retarder is applied (periodically verify that they are working).
- Anti-lock brake systems send a signal to the transmission TCM/ECU to indicate that the brake system is activated.

NOTE: The retarder is automatically disabled and the lockup clutch is disengaged whenever the vehicle anti-lock brake system (ABS) is active. However, in case the ABS system malfunctions, it is recommended that the retarder enable switch, if present, be disabled.

A hydraulic retarder is available on all of the models covered in this manual. The retarder is activated and controlled in various ways. The control depends upon the vehicle type and particular duty cycle. Both manual and automatic controls are available. Automatic controls are applied by the TCM/ECU. In Allison 4th Generation Control systems, the TCM may also activate or limit retarder operation in response to torque speed control or electronic retarder control messages received on the vehicle's J1939 Data Link. Some types of controls and the amount of retarder application are shown in the Types of Retarder Control table that follows.

The presence of a retarder must be "autodetected" as part of Allison 4th Generation Controls and the WTEC III control system.

NOTE: If your transmission has a retarder but it is not functioning, it may not have been "autodetected" during vehicle manufacture. Go immediately to your nearest Allison Transmission service outlet to have "autodetect" reset or the retarder enabled using the Allison DOC™ For PC–Service Tool.

NOTE: When reduced retarder performance is observed, be sure the transmission fluid level is within the operating band on the dipstick (refer to Figure 11). Low fluid level is a common cause for retarder performance complaints.

NOTE: The retarder requires about one second to reach full capacity requested. Be sure to anticipate this delay when using the retarder. Anticipation will prevent unnecessary service brake applications during non-emergency stops.

Types of Retarder Control

Type	Description	Amount of Application
Manual	Separate apply pedal	Zero to Full apply
	Hand lever *	Six levels based on lever position
Automatic	Auto "Full On" *	"Full On" when closed throttle sensed
Brake Pressure Apply**	Single pressure switch	Off or "Full On" (based on brake pressure)
	Three pressure switches	$^1/_3$, $^2/_3$, or "Full On" (based on brake pressure)
Pedal Position **	Special brake pedal	$^1/_3$, $^2/_3$, or "Full On" (based on pedal position)
J1939 Data Link	Digital message from engine controller	Zero to Full Apply
Combinations of the above systems **	Auto "half-on" plus pressure switch *	Half capacity at closed throttle or "Full On" with brake pressure
	Auto "$^1/_3$ on" plus two pressure switches *	$^1/_3$, capacity at closed throttle or $^2/_3$ and "Full On" with brake pressure
	Hand lever plus pressure switch *	6 levels of modulation with lever, or "Full On" with brake pressure
	Foot pedal plus pressure switch	Full modulation with separate pedal, or "Full On" with brake pressure
	Hand lever plus interface for special pedal *	6 levels of modulation with lever, or 3 levels of modulation based on pedal position

* A number between 8 and 1 that flashes during the countdown period.

** For retarder apply systems integrated with the service brake system, the retarder is most effective when applied with light brake pedal pressure for 1–2 seconds to allow the retarder to fully charge. Added pedal pressure can be applied when more aggressive braking is desired.

NOTE: When the transmission fluid or engine water temperature (engine water is an OEM option) exceeds programmed limits, retarder capacity is automatically gradually reduced to minimize or avoid possible system overheating.

Contact your vehicle manufacturer to understand how the retarder controls have been integrated into your vehicle.

CAUTION: Observe the following cautions when driving a vehicle equipped with a retarder:

- THE RETARDER WORKS ONLY WHEN THE ENGINE IS AT CLOSED THROTTLE.
- OBSERVE TRANSMISSION AND ENGINE TEMPERATURE LIMITS AT ALL TIMES. Select the lowest possible transmission range to increase the cooling system capacity and total retardation available.
- In the event of OVERHEATING, DECREASE THE USE OF THE RETARDER; USE THE SERVICE BRAKES TO SLOW THE VEHICLE.
- OBSERVE THE RETARDER/SUMP “OVERTEMP” LIGHT to be sure it responds properly to retarder temperature.

NOTE: Transmission fluid level must be set correctly for highest retarder effectiveness. As much as 2 liters (2 quarts) too high or too low can reduce retarder effectiveness and increase transmission temperature.

RANGE PRESELECTION

NOTE: Preselecting during normal operation may result in reduced fuel economy.

Range preselection means selecting a lower range to match driving conditions encountered or expect to be encountered. Learning to take advantage of preselected shifts will give you better control on slick or icy roads and on downgrades.

Downshifting to a lower range increases engine braking. The selection of a lower range often prevents cycling between that range and the next higher range on a series of short up-and-down hills.

COLD WEATHER STARTS

All 3000 and 4000 Product Families transmissions are programmed to restrict full operation until specific fluid temperatures are reached. Refer to the following table for temperature restrictions.

Minimum Fluid Operating Temperatures

Sump Fluid Temperature	CHECK TRANS Light	Operation
–32°C (–25°F) to –7°C (19°F)	OFF	Neutral, Reverse, Second
–7°C (19°F)	OFF	Full operation in all ranges

NOTE: When sump temperature is below 10°C (50°F) and transmission fluid is C4 (**not DEXRON® or TranSynd™**), follow these procedures when making directional shift changes:

- To shift from forward to reverse, select **N** (Neutral) and then **R** (Reverse).
- To shift from reverse to forward, select **N** (Neutral) and then **D** (Drive) or other forward range.

Failure to follow these procedures may cause illumination of the **CHECK TRANS** light and the transmission will be restricted to **N** (Neutral).

Transmission operation at cold ambient temperatures may require preheating or the use of a lower viscosity transmission fluid. Refer to RECOMMENDED AUTOMATIC TRANSMISSION FLUID AND VISCOSITY GRADE in the Care And Maintenance section.

DRIVING ON SNOW OR ICE

WARNING: Using the retarder on wet or slippery roads may cause loss of traction on the drive wheels—your vehicle may slide out of control. To help avoid injury or property damage, turn the retarder enable to OFF when driving on wet or slippery roads.

NOTE: The retarder is automatically disabled whenever the vehicle ABS is active. However, in case the anti-lock brake system (ABS) malfunctions, it is recommended that the retarder enable switch, if present, be disabled.

If possible, reduce vehicle speed and select a lower range before losing traction. Select the range that will not exceed the speed expected to be maintained.

Accelerate or decelerate very gradually to prevent the loss of traction. It is very important to decelerate gradually when a lower range is selected. It is important that you reach the selected lower range before attempting to accelerate. This will avoid an unexpected downshift during acceleration.

ROCKING OUT

WARNING: To help avoid injury or property damage caused by sudden movement of the vehicle, do not make shifts from **N** (Neutral) to **D** (Drive) or **R** (Reverse) when the throttle is open. The vehicle will lurch forward or rearward and the transmission can be damaged. Avoid this condition by making shifts from **N** (Neutral) to a forward range or **R** (Reverse) only when the throttle is closed and the service brakes are applied.

CAUTION: DO NOT make **N** (Neutral) to **D** (Drive) or directional shift changes when the engine rpm is above idle. Also, if the wheels are stuck and not turning, do not apply full power for more than 10 seconds in either **D** (Drive) or **R** (Reverse). Full power for more than 10 seconds under these conditions will cause the transmission to overheat. If the transmission overheats, shift to **N** (Neutral) and operate the engine at 1200–1500 rpm until it cools (2–3 minutes).

If the vehicle is stuck in deep sand, snow, or mud, it may be possible to rock it out using the following procedure:

1. Shift to **D** (Drive) and apply steady, light throttle (**never full throttle**).
2. When the vehicle has rocked forward as far as it will go, apply and hold the vehicle service brakes.
3. When engine has returned to idle, select **R** (Reverse).
4. Release the brakes and apply a steady, light throttle allowing the vehicle to rock in **R** (Reverse) as far as it will go.
5. Again, apply and hold the service brakes and allow the engine to return to idle.

This procedure may be repeated in **D** (Drive) and **R** (Reverse) if each directional shift continues to move the vehicle a greater distance. **Never** make **N** (Neutral)-to-**D** (Drive) or directional shift changes when the engine rpm is above idle.

HIGH FLUID TEMPERATURE

The transmission is considered to be overheated when any of the following temperatures are exceeded:

Sump fluid	121°C (250°F)
Fluid to cooler	149°C (300°F)
Retarder out fluid	165°C (330°F)

If the transmission overheats during normal operations, check the fluid level in the transmission. Refer to the fluid level check procedures described in the CARE AND MAINTENANCE section.

CAUTION: The engine should never be operated for more than 10 seconds at full throttle with the transmission in range and the output stalled. Prolonged operation of this type will cause the transmission fluid temperature to become excessively high and will cause severe overheat damage to the transmission.

If the engine temperature gauge indicates a high temperature, the transmission is probably overheated. Stop the vehicle and check the cooling system. If it appears to be functioning properly, run the engine at 1200–1500 rpm with the transmission in **N** (Neutral). This should reduce the transmission and engine temperatures to normal operating levels in 2 or 3 minutes. If temperatures do not decrease, reduce the engine rpm.

If the engine temperature indicates a high temperature, an engine or radiator problem is indicated. If high temperature in either the engine or transmission persists, stop the engine and have the overheating condition investigated by maintenance personnel.

PARKING BRAKE

WARNING: If you leave the vehicle and the engine is running, the vehicle can move unexpectedly and you or others could be injured. If you must leave the engine running, **DO NOT LEAVE** the vehicle until you have completed all of the following procedures:

- Put the transmission in **N** (Neutral).
- Be sure the engine is at low idle (500–800 rpm).
- Apply the parking brake and emergency brake and make sure they are properly engaged.
- Chock the wheels and take other steps necessary to keep the vehicle from moving.

The parking brake is only intended to secure an unattended vehicle with the engine ignition **OFF**. Always maintain the vehicle parking brake system according to the manufacturer's specifications. The parking brake may not have sufficient capacity to restrain a vehicle with the engine running and the transmission in a forward or reverse-range. When the vehicle is unattended and the engine is in operation, the transmission **must be in N** (Neutral) with the **brakes fully applied** and the **wheels chocked**.

TOWING OR PUSHING

CAUTION: Failure to lift the driving wheels off the road, disconnect the driveline, or remove the axle shafts before pushing or towing can cause serious transmission damage.

The engine cannot be started by pushing or towing. Before pushing or towing a vehicle do one of the following:

- Disconnect the driveline.
- Lift the drive wheels off the road.
- Remove the axle shafts from the drive wheels.

An auxiliary air supply will usually be required to actuate the vehicle brake system.

When the axle shafts are removed, be sure to cover the wheel openings to prevent loss of lubricant and entry of dust and dirt.

TURNING OFF THE VEHICLE

Always select **N** (Neutral) prior to turning off the vehicle engine.

PRIMARY/SECONDARY SHIFT SCHEDULES

The points at which shifts occur depend upon predetermined speeds and other operating conditions. A transmission “shift calibration” includes several sets of shift points which may be used according to current or anticipated operating conditions. Some shift schedules may be inhibited as a result of operating conditions, such as engine or transmission fluid temperature. Shift schedules may be changed using the **MODE** button (some applications may use a dash-mounted switch)—which is typically associated with a change in anticipated vehicle operation.

The TCM/ECU includes the capacity for two separate and distinct shift calibrations (customer-selectable), one for use in “Primary Mode” of operation and one in “Secondary Mode.”

- **Primary**—This shift schedule is typically used for all normal vehicle operations.
- **Secondary**—This is an alternate shift schedule that the TCM/ECU uses upon request. Not all vehicles will be equipped with a secondary shift schedule. The request can be interlocked with a vehicle component, or be operator-controlled using the **MODE** button.

Your vehicle may have a dash-mounted light that illuminates when the secondary mode is active.

CRUISE CONTROL OPERATION

Operating an Allison WTEC III Controls or Allison 4th Generation Controls-equipped vehicle on cruise control may cause the transmission to shift cycle if the cruise control speed setting is set too close to a scheduled shift point. One of the following actions may eliminate shift cycling:

- Select the secondary shift schedule by pushing the **MODE** button (refer to Figure 5 or Figure 6) on the shift selector.
- Select a lower range by pushing the ↓ (Down) arrow or moving the lever on the shift selector.
- Change the cruise control setting away from the shift point.

Some vehicles equipped with an engine brake and Allison WTEC III Controls or Allison 4th Generation Controls-equipped transmission will have the engine brake controlled by the TCM/ECU. This is done so the transmission will automatically select a lower range when the engine brake is turned on and the throttle is near idle position.

Operating a vehicle on cruise control with the engine brake turned on and controlled by the transmission TCM/ECU, may cause an unwanted application of the engine brake when the cruise control decelerates for downhill grades. Eliminate this condition by turning off the engine brake while operating the vehicle on cruise control.

ADAPTING SHIFTS

When poor shift quality is due to the installation of a new or recalibrated TCM/ECU, use the following procedure to restore good shift quality by completing a prescribed number of shifts in a relatively short time instead of over several days of operation.

NOTE: Shift concerns may indicate the transmission has never had the shifts fully adapted.

The adaptive feature does not function below 100°F transmission sump temperature. Normal sump temperature is recommended before this procedure is followed.

Check transmission sump level and assure it is set to “Hot Full” at normal sump temperature before this procedure is followed.

All segments of this procedure are to be repeated a **minimum of 5 times** or until shift quality variation is indistinguishable from shift to shift.

1. From Neutral, with parking brake set and service brakes applied via foot pedal, select the following sequence: Drive, Neutral, Reverse, Neutral, Drive, Reverse, Drive, Neutral. Allow each shift to fully complete before selecting the next shift.
2. Release all brakes and perform this sequence: Wide Open Throttle (WOT) 1–2; once shift is complete, release the throttle to closed and decelerate to just prior to the Closed Throttle (CT) 2–1 and perform a Step Thru (ST) 2–1 by going to WOT.
3. Continue the process initiated in Step 2 for each Upshift and Downshift combination available. Example: Wide Open Throttle (WOT) 2–3; once shift is complete, release the throttle to closed and decelerate to just prior to the Closed Throttle (CT) 3–2 and perform a Step Thru (ST) 3–2 by going to WOT. Repeat for the WOT 3–4/ST 4–3, WOT 4–5/ST 5–4, WOT 5–6/ST 6–5.
4. From a Stop, release vehicle brakes and perform a set of Part Throttle (PT—50 to 60 percent) Upshifts to the highest attainable range for the vehicle. Release the throttle to closed and use light vehicle brakes to decelerate to a stop.

NOTE: If the vehicle is equipped with an output retarder or engine brake system, these systems should be turned off for this segment.

5. From a Stop, release vehicle brakes and perform Part Throttle (PT—50 to 60 percent) Upshifts to the 3rd range. Release the throttle to closed and, using moderate to heavy vehicle brakes (NOT panic or wheel lock), decelerate to a stop.

NOTE: Braking should be aggressive but not to the level that would cause passenger complaints. If the vehicle is equipped with an output retarder or engine brake system, these systems should be turned off for this segment.

6. From a Stop, release vehicle brakes and perform a set of Wide Open Throttle Upshifts to the highest attainable range for the vehicle. Release the throttle to Closed and Preselect Down to 1st Range using the shift selector. Use light vehicle brakes to decelerate to a stop.

7. If the vehicle is equipped with a retarder or engine brake, turn that system on for this segment. From a Stop, release vehicle brakes and perform a set of Wide Open Throttle Upshifts to the highest attainable range for the vehicle. Release the throttle to Closed and, using light vehicle brakes and the retarder or engine brake, decelerate vehicle to a stop.

NOTE: Allison Transmission does not recommend using the vehicle brakes to “force” Powered Downshifts (PD, downshifts with the throttle applied). If grades are available, these should be used to adapt in WOT and PT Powered Downshifts.

8. Approach the grade in the highest safely attainable range and hold the throttle steady at WOT and allow the vehicle to perform the Powered Downshifts as required to ascend the grade.
9. Approach the grade in the highest safely attainable range and hold the throttle steady at Part Throttle (PT—50 to 60 percent) and allow the vehicle to perform the Powered Downshifts as required to ascend the grade.

MOTORHOME SERIES

POWER TAKEOFF OPERATION

POWER TAKEOFF OPERATION

CAUTION: Do not exceed the engagement and operational speed limits imposed on the driven equipment during the operation of the PTO. Exceeding the speed limits produces high hydraulic pressure in the PTO that can damage the PTO components. Consult the vehicle manufacturer's literature for these speed limits.

If a PTO is present, it will be mounted on either the left side or right side of the 3000 MH transmission. The PTO is located on the left side or top of the 4000 MH transmission. The PTO drive gear is engine-driven and therefore provides direct engine power. The PTO can be operated when the vehicle is either moving or stopped.

The PTO gear is in constant mesh with the drive gear in the converter housing. PTOs are either constant-drive (output always powered) or clutched drive. The output of a clutched drive PTO is powered when the PTO clutch is pressurized.

Be sure the limits for PTO engagement speed and operational speed are not exceeded. Consult the vehicle manufacturer's literature for these speed limits. Also, all Motorhome Series-equipped vehicles with PTO enable have engagement and operational speed limits programmed into the TCM/ECU to help protect PTO equipment. Some speed limits have default values which are programmed out of the operating range and will need to be set for your particular PTO duty cycle. Consult your vehicle manufacturer to see if your transmission has been programmed and what operational limits have been established.

When the programmed engagement speed is exceeded, the PTO will not engage. The PTO engagement must be retried after the speed has been reduced. When operational speeds (either engine or transmission output) are exceeded, the PTO will deactivate and the PTO engagement process must be repeated.

MOTORHOME SERIES

CARE AND MAINTENANCE

PERIODIC INSPECTIONS

Careful attention to the fluid level and connections for the electronic and hydraulic circuits is very important.

For easier inspection, the transmission should be kept clean. Make regular periodic inspections and checks:

- For loose bolts.
- For leaking fluid around fittings, lines, and transmission openings.
- The condition of the electrical harnesses.
- The engine cooling system for presence of transmission fluid and check the transmission fluid for presence of coolant, which would indicate a faulty oil cooler.
- The breather (refer to Figure 1 through Figure 4) to make sure it is clean and free from dirt or debris.

Report any abnormal condition to service management.

PREVENT MAJOR PROBLEMS

Help Allison 4th Generation Controls or WTEC III Controls oversee the operation of the transmission. Minor problems can be kept from becoming major problems if an Allison Transmission distributor or dealer is notified when one of these conditions occur:

- Shifting feels odd.
- Transmission leaks fluid.
- Unusual transmission-related sounds (changes in sound caused by normal engine thermostatic fan cycling, while climbing a long grade with a heavy load, have been mistaken for transmission-related sounds).
- **CHECK TRANS** light comes on frequently.

IMPORTANCE OF PROPER FLUID LEVEL

It is important that the proper fluid level be maintained at all times because the transmission fluid cools, lubricates, and transmits hydraulic power. If the fluid level is too low, the converter and clutches do not receive an adequate supply of fluid. If fluid level is too high, the fluid can aerate. Aerated fluid can cause the transmission to shift erratically or overheat.

An oil level sensor (OLS) is optional on all WTEC III transmissions and standard on all Allison 4th Generation transmissions (except 3000 Product Family 7-speed). The OLS allows the operator to obtain an indication of the fluid level from the full-function shift selector. However, no OLS information is available unless the OLS is "autodetected" by the TCM/ECU.

Frequently check for the presence of oil level diagnostics if the transmission is known to contain an OLS. If an OLS is not detected during a fixed number of engine starts, the WTEC III or Allison 4th Generation Controls system concludes that no OLS is present. If an OLS is known to be present, but has not been detected, then troubleshooting of the OLS circuit is required. After the OLS circuit is repaired, reset "autodetect" or manually select the OLS function using Allison DOC™ For PC–Service Tool. For detailed troubleshooting procedures refer to the Troubleshooting Manual. Refer to the SERVICE LITERATURE section for specific publication numbers.

NOTE: To correctly check the transmission fluid level using the dipstick, the transmission fluid must be at operating temperature. The oil level sensor method of checking the fluid level compensates for transmission fluid temperature between 60°C–104°C (140°F–220°F). Any temperature below 60°C (140°F) or above 104°C (220°F) will result in an **Invalid for Display** condition.

FLUID LEVEL CHECK USING PUSHBUTTON OR LEVER SHIFT SELECTOR

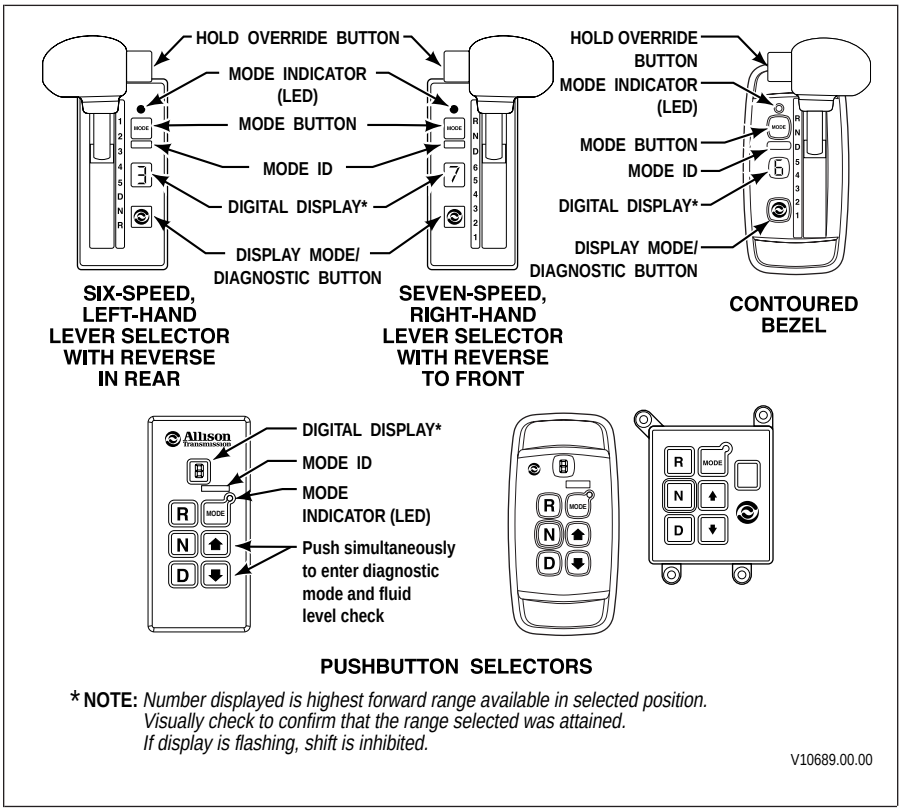


Figure 9. WTEC III Controls Shift Selectors and Pushbutton Selectors

The transmission must be equipped with the oil level sensor to be able to read fluid level information.

NOTE: WTEC III Controls pushbutton and lever selectors display fluid level information one character at a time. Allison 4th Generation Controls pushbutton and lever selectors display fluid level information two characters at a time.

1. Park the vehicle on a level surface, shift to **N** (Neutral), and apply the parking brake.
2. **Pushbutton shift selector**—If equipped with an oil level sensor, simultaneously press the ↑ (Up) and ↓ (Down) arrow buttons once.

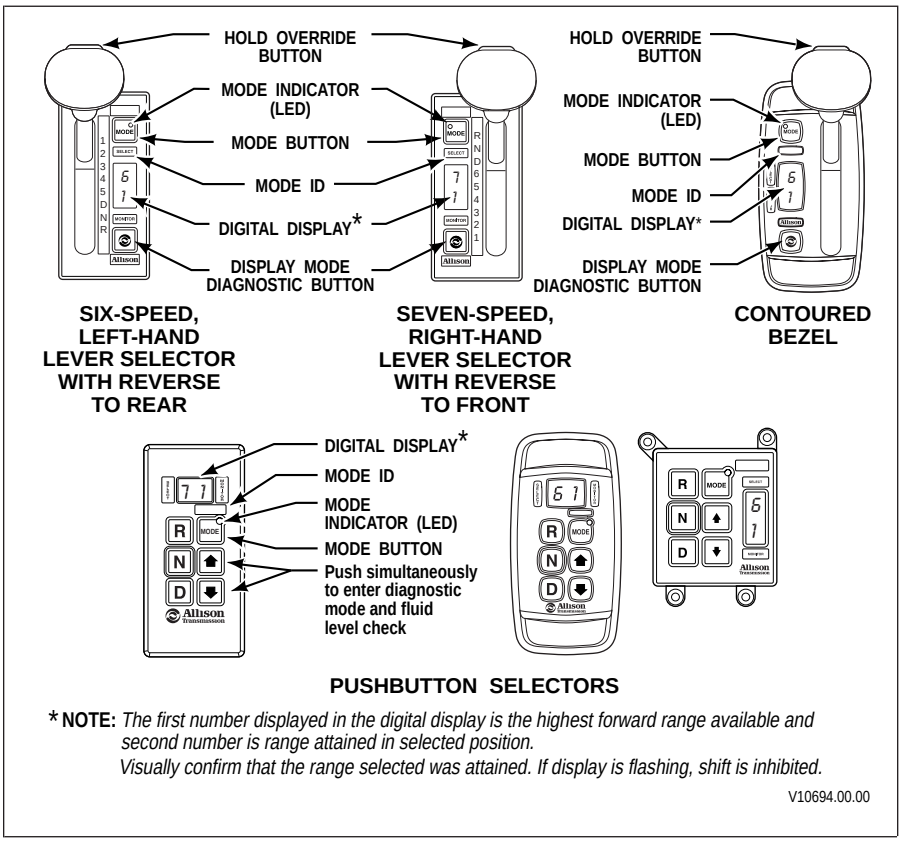


Figure 10. Allison 4th Generation Controls Shift Selectors and Pushbutton Selectors

3. **Lever shift selector**—If equipped with an oil level sensor, press the display mode button one time.

NOTE: The fluid level check may be delayed until the following conditions are met:

- The fluid temperature is above 60°C (140°F) and below 104°C (220°F).
- The transmission is in **N** (Neutral).
- The engine is at idle.
- The transmission output shaft is stopped.
- The vehicle has been stationary for approximately two minutes to allow the fluid to settle.

A delayed fluid level check for transmissions with WTEC III Controls (refer to Figure 9) is indicated by a "—" in the display window followed by a numerical countdown. The countdown, starting at 8, indicates the time remaining in the two minutes settling period.

The indication of a delayed fluid level check for Allison 4th Generation Controls (refer to Figure 10) is a flashing "—" in the display under **SELECT** and a digit countdown from 8 to 1 in the display under **MONITOR**.

- **Correct Fluid Level**—"**o L**" is displayed ("**o L**" represents "Fluid (Oil) Level Check Mode"), followed by "**o K**". The "**o K**" display indicates the fluid is within the correct fluid level zone. The sensor display and the transmission dipstick may not agree exactly because the oil level sensor compensates for fluid temperature.

NOTE: WTEC III Controls displays fluid level diagnostic information one character at a time.

Allison 4th Generation Controls displays fluid level diagnostic information two characters at a time.

- **Low Fluid Level**—"**o L**" is displayed ("**o L**" represents "Fluid (Oil) Level Check Mode"), followed by "**L o**" ("**L o**" represents "Low Oil Level") and the number of quarts the transmission fluid is low.
  Example: **o L L o 0 2**
  Where "2" indicates that 2 additional quarts of fluid will bring the fluid level within the middle of the "**o K**" zone.
- **High Fluid Level**—"**o L**" is displayed ("**o L**" represents "Fluid (Oil) Level Check Mode"), followed by "**H I**" ("**H I**" represents "High Oil Level") and the number of quarts the transmission is overfilled.
  Example: **o L H I 0 1**
  Where "1" indicates 1 quart of fluid above the full transmission level.
- **Invalid for Display** — "**o L**" is displayed ("**o L**" represents "Fluid (Oil) Level Check Mode"), followed by "**—**" (for WTEC III Controls) or "**– –**" (for Allison 4th Generation Controls) and a numerical display (alphabetical display for MY08). The numerical display (alphabetical display for MY08) is a fault code and indicates conditions are not proper to receive the fluid level information, or that there is a system malfunction. The fault codes that may be encountered are shown in the Fluid Level Fault Codes tables:

Fluid Level Fault Codes (for WTEC III Controls)

Display	Cause of Code
o,L, —, 0, X	Settling time too short*
o,L, —, 5, 0	Engine speed (rpm) too low
o,L, —, 5, 9	Engine speed (rpm) too high
o,L, —, 6, 5	Neutral must be selected

Fluid Level Fault Codes (for WTEC III Controls) *(cont'd)*

Display	Cause of Code
o,L, —, 7, 0	Sump fluid temperature too low
o,L, —, 7, 9	Sump fluid temperature too high
o,L, —, 8, 9	Output shaft rotation
o,L, —, 9, 5	Sensor failure**

* A number between 8 and 1 that flashes during the countdown period.

** Speed sensor, throttle position sensor, temperature sensor, or oil level sensor failure display should be reported to a distributor or dealer in your area (consult the telephone directory for an Allison Transmission distributor or dealer).

Fluid Level Fault Codes (for Allison 4th Generation Controls)

Display (Old)	Display (MY08e, Cal/Sfw or newer)	Cause of Code
oL, - -,0X	oL, - -,0X	Settling time too short*
oL, - -,50	oL, - -,EL	Engine speed (rpm) too low
oL, - -,59	oL, - -,EH	Engine speed (rpm) too high
oL, - -,65	oL, - -,SN	Neutral must be selected
oL, - -,70	oL, - -,TL	Sump fluid temperature too low
oL, - -,79	oL, - -,TH	Sump fluid temperature too high
oL, - -,89	oL, - -,SH	Output shaft rotation
oL, - -,95	oL, - -,FL	Sensor failure**

* A number between 8 and 1 that flashes during the countdown period.

** Speed sensor, throttle position sensor, temperature sensor, or oil level sensor failure display should be reported to a distributor or dealer in your area (consult the telephone directory for an Allison Transmission distributor or dealer).

CAUTION: A low or high fluid level can cause overheating and irregular shift patterns. Incorrect fluid level can damage the transmission.

NOTE: To exit the fluid level display mode, press any range button on the pushbutton shift selector, or press the display mode (diagnostic) button once on the lever shift selector.

MANUAL FLUID LEVEL CHECK PROCEDURE

Refer to Figure 1 through Figure 4 for the location of the fill tube and dipstick.

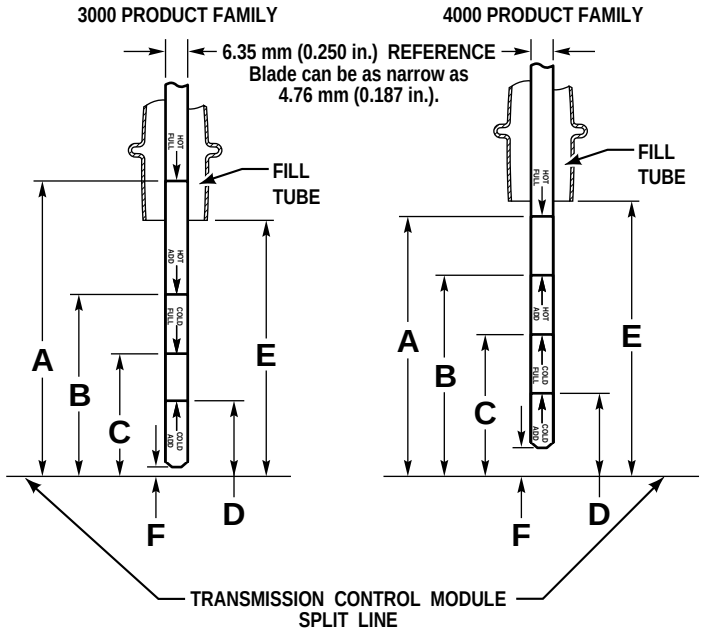
WARNING: If you leave the vehicle and the engine is running, the vehicle can move unexpectedly and you or others could be injured. If you must leave the engine running, do not leave the vehicle until you have completed all of the following procedures:

1. Put the transmission in **N** (Neutral).
2. Be sure the engine is at low idle (500–800 rpm).
3. Apply the parking brakes and emergency brake and make sure they are properly engaged.
4. Chock the wheels and take any other steps necessary to keep the vehicle from moving.

Clean around the end of the fill tube before removing the dipstick. This will aid in preventing dirt or foreign matter from entering the hydraulic system, which can cause:

- Valves to stick.
- Undue wear of transmission parts.
- Clogged passages.

Check the fluid level using the procedures in COLD CHECK and HOT CHECK. Report an abnormal fluid level to service management.



OIL SUMP	TRANSMISSION/SUMP DESCRIPTION	DIMENSION A	DIMENSION B	DIMENSION C	DIMENSION D	DIMENSION E	DIMENSION F**
2.00 in. and 4.00 in.****	4000 PRODUCT FAMILY	106.7 mm (4.20 in.)	76.2 mm (3.00 in.)	66.0 mm (2.60 in.)	*	132.6 mm (5.22 in.)	13.8 mm (0.54 in.)
2.00 in.***	3000 PRODUCT FAMILY	101.6 mm (4.00 in.)	73.7 mm (2.90 in.)	50.8 mm (2.00 in.)	*	86.6 mm (3.41 in.)	5.9 mm (0.23 in.)
4.00 in.***	3000 PRODUCT FAMILY	101.6 mm (4.00 in.)	63.5 mm (2.50 in.)	45.7 mm (1.80 in.)	*	86.6 mm (3.41 in.)	5.9 mm (0.23 in.)

NOTE: *Calibrate level marking locations with respect to transmission control module split line and fill tube.*
Scale none.
**Dimension determined by installation.*
***Reference dimension only. Actual dimension to be determined by installation.*
****Reference drawing AS66-60.*
*****Reference drawing AS67-60.*

V07301.00.01

Figure 11. Standard Transmission Dipstick Markings

COLD CHECK

The Cold Check determines if the transmission has enough fluid to be operated safely until a Hot Check can be made.

NOTE: The correct fluid level **can not be determined** unless the transmission is in a level position.

CAUTION: DO NOT start the engine until the presence of sufficient transmission fluid has been confirmed. Remove the transmission fluid dipstick and be sure the static fluid level is near the HOT FULL mark.

CAUTION: The fluid level rises as fluid temperature rises. DO NOT fill the transmission above the "COLD CHECK" band if the transmission fluid is below normal operating temperatures. During operation, an overfull transmission can become overheated, leading to transmission damage.

A cold check may be made after initial start-up and the presence of transmission fluid has been confirmed—the sump fluid temperature is then typically 16°–49°C (60°–120°F). To perform a COLD CHECK, do the following:

1. Start the engine and run it at idle (500–800 rpm) in **N** (Neutral) for about one minute.
2. Shift to **D** (Drive) and then to **R** (Reverse) to clear the hydraulic circuits of air.
3. Shift to **N** (Neutral) and leave engine at idle.
4. Move the vehicle to a level surface, put transmission in **N** (Neutral), and set the parking brake.
5. With the engine idling (500–800 rpm), shift to **D** (Drive) and then to **R** (Reverse) to clear air from the hydraulic circuits.
6. Shift to **N** (Neutral) and leave engine at idle.
7. Remove the dipstick and wipe it clean. Insert the dipstick into the fill tube, pushing down until it stops.
8. Remove the dipstick and observe the fluid level. If the fluid on the dipstick is within the COLD CHECK band (refer to Figure 11), the level is satisfactory. If the fluid level **is not** within this band, add or drain fluid as necessary to bring the level within the COLD CHECK band.
9. Perform a Hot Check at the first opportunity after normal operating temperature (71°–93°C; 160°–200°F) is reached.

CAUTION: DO NOT operate the transmission for extended periods of time until a Hot Check has verified proper fluid level. Transmission damage can result from extended operation at improper fluid level conditions.

CAUTION: Obtain an accurate fluid level by imposing the following conditions:

- Engine is idling (500–800 rpm) in **N** (Neutral)
- Transmission fluid is at the normal operating temperature
- The vehicle is on a level surface

HOT CHECK

The transmission fluid **must be hot** to obtain an accurate check, because the fluid level rises as the temperature increases.

To perform a HOT CHECK, do the following:

1. Be sure fluid has reached normal operating temperature (71°–93°C; 160°–200°F). If a transmission temperature gauge is not present, check fluid level when the engine water temperature gauge has stabilized and the transmission has been operated under load for at least one hour.
2. Park the vehicle on a level surface and shift to **N** (Neutral). Apply the parking brake and allow the engine to idle (500–800 rpm).
3. Remove the dipstick and wipe it clean. Insert the dipstick into the fill tube, pushing down until it stops.
4. Remove the dipstick and observe the fluid level. The safe operating level is anywhere within the HOT RUN band on the dipstick.
5. If the level is not within this band, add or drain fluid as necessary to bring the level within the HOT RUN band.
6. Be sure fluid level checks are consistent. Check fluid level more than once and if readings are not consistent, check to be sure the transmission breather is clean and not clogged. If readings are still not consistent, contact your nearest Allison distributor or dealer.

RECOMMENDED AUTOMATIC TRANSMISSION FLUID AND VISCOSITY GRADE

Proper transmission fluid selection is important to transmission performance, reliability, and durability. The following is a list, by preference of use, of Allison approved transmission fluids.

NOTE: Consult the Allison Transmission web site at *www.allisontransmission.com* for a current list of approved transmission fluids. Select service, then fluids.

- TranSynd™/TES 295 approved fluids:
  - — Recommended for all 3000 and 4000 Product Families transmission applications
  - — Fully qualified to the Allison TES 295 specification for Severe Duty and Extended Drain Intervals
  - — Available through Allison distributors and dealerships
- TES 389 approved fluid:
  - — May be used in all 3000 and 4000 Product Families transmission applications
  - — **Must use** Allison approved non-TES 295 fluid/filter change schedule that was previously assigned to DEXRON®-III fluid.
- DEXRON®-VI approved fluid:
  - — As of January 1, 2007, General Motors will no longer license DEXRON®-III fluids. DEXRON®-VI fluids are suitable replacements.
  - — DEXRON®-VI may be used in all 3000 and 4000 Product Families transmission applications after February 1, 2007, starting with serial number 6510717075 for 3000 Product Family transmissions and serial number 6610220990 for all 4000 Product Family transmissions.
  - — **Must use** the Allison approved non-TES 295 fluid/filter change schedule that was previously assigned to DEXRON®-III fluid.
- Some C4 fluids that meet Allison TES 228 specifications are approved for use in some Allison transmissions. These fluids are listed on the Allison Transmission web site.

CAUTION: Disregarding minimum fluid temperature limits may result in transmission malfunction or reduced transmission life.

- When choosing the optimum viscosity grade of fluid, duty cycle, preheat capabilities, and/or geographical location **must be** taken into consideration. The Transmission Fluid Operating Temperature Requirements table lists the minimum fluid temperatures at which the transmission may be safely operated without preheating. Preheat with auxiliary heating equipment or by running the equipment or vehicle with the transmission in neutral for a minimum of 20 minutes before attempting range operation.

Transmission Fluid Operating Temperature Requirements

SAE Viscosity Grade* or Fluid Type	Minimum Operating Temperature	
	Celsius	Fahrenheit
MIL-PRF-46167	–32	–25
SAE 0W-30	–30	–22
SAE 0W-20 or TranSynd™/TES 295	–35	–31
DEXRON®-VI/TES 389	–25	–13
SAE 10W	–25	–13
SAE 15W-40	–20	–4
SAE 30	0	32
SAE 40	10	50
* SAE "W" designation indicates winter weight based on cold temperature properties.		

KEEPING FLUID CLEAN

CAUTION: Containers or fillers that have been used for antifreeze solution or engine coolant must NEVER be used for transmission fluid. Antifreeze and coolant solutions contain ethylene glycol which, if put into the transmission, can cause the clutch plates and some seals to fail.

It is absolutely necessary that transmission fluid be clean. The fluid **must be handled** in clean containers to prevent foreign material from entering the transmission.

FLUID AND INTERNAL FILTER CHANGE INTERVAL RECOMMENDATIONS

CAUTION: Transmission fluid and filter change frequency is determined by the severity of transmission service. To help avoid transmission damage, more frequent changes may be necessary than recommended in the general guidelines due to operating conditions and duty cycle.

NOTE: Change fluid/filters at or before recommended mileage, months, or hours have elapsed, whichever occurs first. For vehicles that average less than 25 mph (40 kmh), operating hours represent a more reliable measure of fluid life; therefore, fluid change intervals should not be based on mileage only.

Allison Transmission requires all 3000 and 4000 Product Families transmissions using the **Gold Series filter** to change the main filter (not the lube filter) **after the first 5000 miles (8000 km) or 200 hours of operation,** whichever occurs first. Gold Series filters may be identified by part numbers 29538231 or 29538232 stamped into the filter end cap.

Beginning with serial numbers 6510670912, 6610205144, 6520067342, and 6620002521, transmissions equipped with Allison High-capacity filter **do not require an initial main filter change at 5000 miles (8000 km) or 200 hours**. High-capacity filters may be identified by part numbers 29545777 or 29545780 stamped into the filter end cap.

Refer to the latest revision of Service Tips #1099 for convenient kit and fluid information. Refer to the appropriate mechanic's tips, latest revision, for location of the main filter and fluid/filter change procedures. The latest revision of Service Tips #1099 is available on the Allison Transmission web site under service. The latest revision of the appropriate mechanic's tips is available on the Allison Transmission web site under publications. The web site is located at *www.allisontransmission.com.*

CAUTION: Transmission fluid and filters **must be changed** whenever there is evidence of dirt or high temperature conditions. A high temperature condition is indicated when the transmission fluid is discolored, has a strong odor, or has exceeded oil analysis limits.

Recommended Fluid/Filter Change Intervals for 3000 Product Family Transmissions with Gold Series Filter

NOTE: Change fluid/filters at or before recommended mileage, months, or hours have elapsed, whichever occurs first.

NOTE: Local conditions, severity of operation or duty cycle may require more or less frequent fluid change intervals that differ from the published recommended fluid change intervals of Allison Transmission. Allison Transmission recommends that the customer use fluid analysis as the primary method for determining fluid change intervals. In the absence of a fluid analysis program, the fluid change intervals listed in the chart should be used.

SEVERE VOCATION*				GENERAL VOCATION**			
	Filters				Filters		
Fluid	Main	Internal	Lube/ Auxiliary	Fluid	Main	Internal	Lube/ Auxiliary
Schedule 1—Non-TranSynd™/Non-TES 295 Fluid							
12,000 Miles (20 000 km) 6 Months 500 Hours	12,000 Miles (20 000 km) 6 Months 500 Hours	Overhaul	12,000 Miles (20 000 km) 6 Months 500 Hours	25,000 Miles (40 000 km) 12 Months 1000 Hours	25,000 Miles (40 000 km) 12 Months 1000 Hours	Overhaul	25,000 Miles (40 000 km) 12 Months 1000 Hours
Schedule 2—TranSynd™/TES 295 Fluid***							
75,000 Miles (120 000 km) 36 Months 3000 Hours	75,000 Miles (120 000 km) 36 Months 3000 Hours	Overhaul	75,000 Miles (120 000 km) 36 Months 3000 Hours	150,000 Miles (240 000 km) 48 Months 4000 Hours	75,000 Miles (120 000 km) 36 Months 3000 Hours	Overhaul	75,000 Miles (120 000 km) 36 Months 3000 Hours

* Transmissions with retarders or on/off highway.

** Transmissions without retarders and on highway only.

*** Recommendations in Schedule 2 are based on the transmission containing 100 percent TranSynd™ fluid and Allison Transmission Gold Series filters.

Recommended Fluid/Filter Change Intervals for 4000 Product Family Transmissions with Gold Series Filter

NOTE: Change fluid/filters at or before recommended mileage, months, or hours have elapsed, whichever occurs first.

NOTE: Local conditions, severity of operation or duty cycle may require more or less frequent fluid change intervals that differ from the published recommended fluid change intervals of Allison Transmission. Allison Transmission recommends that the customer use fluid analysis as the primary method for determining fluid change intervals. In the absence of a fluid analysis program, the fluid change intervals listed in the chart should be used.

SEVERE VOCATION*				GENERAL VOCATION**			
	Filters				Filters		
Fluid	Main	Internal	Lube/ Auxiliary	Fluid	Main	Internal	Lube/ Auxiliary
Schedule 1—Non-TranSynd™/Non-TES 295 Fluid							
12,000 Miles (20 000 km) 6 Months 500 Hours	12,000 Miles (20 000 km) 6 Months 500 Hours	Overhaul	12,000 Miles (20 000 km) 6 Months 500 Hours	25,000 Miles (40 000 km) 12 Months 1000 Hours	25,000 Miles (40 000 km) 12 Months 1000 Hours	Overhaul	25,000 Miles (40 000 km) 12 Months 1000 Hours
Schedule 2—TranSynd™/TES 295 Fluid*** **4 Inch Control Module (3.5 Inch Approximately)**							
75,000 Miles (120 000 km) 36 Months 3000 Hours	75,000 Miles (120 000 km) 36 Months 3000 Hours	Overhaul	75,000 Miles (120 000 km) 36 Months 3000 Hours	150,000 Miles (240 000 km) 48 Months 4000 Hours	75,000 Miles (120 000 km) 36 Months 3000 Hours	Overhaul	75,000 Miles (120 000 km) 36 Months 3000 Hours

* Transmissions with retarders or on/off highway.

** Transmissions without retarders and on highway only.

*** Recommendations in Schedule 2 are based on the transmission containing 100 percent TranSynd™ fluid and Allison Transmission Gold Series filters.

Recommended Fluid/Filter Change Intervals for 4000 Product Family Transmissions with Gold Series Filter (cont'd)

NOTE: Severe and General Vocations—local conditions, severity of operation, or duty cycle may require more or less frequent fluid change intervals that differ from the published recommended fluid change intervals of Allison Transmission. Transmission protection and fluid change intervals can be optimized by using fluid analysis. Filters **must be changed** at or before recommended intervals. Change fluid/filter after recommended mileage, months, or hours have elapsed, whichever comes first.

SEVERE VOCATION*				GENERAL VOCATION**			
	Filters				Filters		
Fluid	Main	Internal	Lube/ Auxiliary	Fluid	Main	Internal	Lube/ Auxiliary
Schedule 3—TranSynd™/TES 295 Fluid*** **2 Inch Control Module (1.75 Inch Approximately)**							
50,000 Miles (80 000 km) 24 Months 2000 Hours	50,000 Miles (80 000 km) 24 Months 2000 Hours	Overhaul	50,000 Miles (80 000 km) 24 Months 2000 Hours	150,000 Miles (240 000 km) 48 Months 4000 Hours	50,000 Miles (80 000 km) 24 Months 2000 Hours	Overhaul	50,000 Miles (80 000 km) 24 Months 2000 Hours

* Transmissions with retarders or on/off highway.

** Transmissions without retarders and on highway only.

*** Recommendations in Schedules 2 and 3 are based on the transmission containing 100 percent TranSynd™ fluid and Allison Transmission Gold Series filters.

Recommended Fluid/Filter Change Intervals for 3000 Product Family Transmission with High Capacity Filter

NOTE: Change fluid/filters at or before recommended mileage, months, or hours have elapsed, whichever occurs first.

NOTE: Local conditions, severity of operation or duty cycle may require more or less frequent fluid change intervals that differ from the published recommended fluid change intervals of Allison Transmission. Allison Transmission recommends that the customer use fluid analysis as the primary method for determining fluid change intervals. In the absence of a fluid analysis program the fluid change intervals listed in the chart should be used.

SEVERE VOCATION*				GENERAL VOCATION**			
	Filters				Filters		
Fluid	Main	Internal	Lube/ Auxiliary	Fluid	Main	Internal	Lube/ Auxiliary
Schedule 1—Non-TranSynd™/Non-TES 295 Fluid							
12,000 Miles (20 000 km) 6 Months 500 Hours	12,000 Miles (20 000 km) 6 Months 500 Hours	Overhaul	12,000 Miles (20 000 km) 6 Months 500 Hours	25,000 Miles (40 000 km) 12 Months 1000 Hours	25,000 Miles (40 000 km) 12 Months 1000 Hours	Overhaul	25,000 Miles (40 000 km) 12 Months 1000 Hours
Schedule 2—TranSynd™/TES 295 Fluid***							
150,000 Miles (240 000 km) 48 Months 6000 Hours	75,000 Miles (120 000 km) 36 Months 3000 Hours	Overhaul	75,000 Miles (120 000 km) 36 Months 3000 Hours	300,000 Miles (480 000 km) 48 Months 6000 Hours	75,000 Miles (120 000 km) 36 Months 3000 Hours	Overhaul	75,000 Miles (120 000 km) 36 Months 3000 Hours

* Transmissions with retarders or on/off highway.

** Transmissions without retarders and on highway only.

*** Recommendations in Schedule 2 are based on the transmission containing 100 percent TranSynd™ fluid and Allison Transmission High Capacity filters.

Recommended Fluid/Filter Change Intervals for 4000 Product Family Transmissions with High Capacity Filter

NOTE: Change fluid/filters at or before recommended mileage, months, or hours have elapsed, whichever occurs first.

NOTE: Local conditions, severity of operation or duty cycle may require more or less frequent fluid change intervals that differ from the published recommended fluid change intervals of Allison Transmission. Allison Transmission recommends that the customer use fluid analysis as the primary method for determining fluid change intervals. In the absence of a fluid analysis program the fluid change intervals listed in the chart should be used.

SEVERE VOCATION*				GENERAL VOCATION**			
	Filters				Filters		
Fluid	Main	Internal	Lube/ Auxiliary	Fluid	Main	Internal	Lube/Auxiliary
Schedule 1—Non-TranSynd™/Non-TES 295 Fluid							
12,000 Miles (20 000 km) 6 Months 500 Hours	12,000 Miles (20 000 km) 6 Months 500 Hours	Overhaul	12,000 Miles (20 000 km) 6 Months 500 Hours	25,000 Miles (40 000 km) 12 Months 1000 Hours	25,000 Miles (40 000 km) 12 Months 1000 Hours	Overhaul	25,000 Miles (40 000 km) 12 Months 1000 Hours
Schedule 2—100 Percent TranSynd™/TES 295 Fluid **2 Inch (1.75 Inch Approximately) and 4 Inch (3.5 Inch Approximately) Control Modules*** **							
150,000 Miles (240 000 km) 48 Months 6000 Hours	75,000 Miles (120 000 km) 36 Months 3000 Hours	Overhaul	75,000 Miles (120 000 km) 36 Months 3000 Hours	300,000 Miles (480 000 km) 48 Months 6000 Hours	75,000 Miles (120 000 km) 36 Months 3000 Hours	Overhaul	75,000 Miles (120 000 km) 36 Months 3000 Hours

* Transmissions with retarders or on/off highway.

** Transmissions without retarders and on highway only.

*** 2 inch Control Module requires Filter Kit P/N 29545776; 4 inch Control Module requires Filter Kit P/N 29545779

Fluid Analysis. Transmission protection and fluid change intervals may be optimized by monitoring fluid oxidation according to the tests and limits shown in the fluid oxidation measurement limits table. Consult your local telephone directory for fluid analysis firms. To be sure of consistent and accurate fluid analysis, use only one fluid analysis firm. Refer to Technician's Guide for Automatic Transmission Fluid, GN2055EN, for additional information.

Fluid Oxidation Measurement Limits

Test	Limit
Viscosity	±25 percent change from new fluid
Total Acid Number (TAN)	+3.0* change from new fluid
Solids	2 percent by volume
* mg of potassium hydroxide (KOH) to neutralize a gram of fluid.	

TRANSMISSION FLUID CONTAMINATION

Fluid Examination. At each fluid change, examine the drained fluid for evidence of dirt or water. A normal amount of condensation will appear in the fluid during operation.

Water. Obvious water contamination of the transmission fluid or transmission fluid in the cooler (heat exchanger) water indicates a leak between the water and fluid areas of the cooler. Inspect and pressure test the cooler to confirm the leak. Replace leaking coolers.

NOTE: Cooler water can also be contaminated by engine oil; be sure to locate the correct source of cooler water contamination.

Engine Coolant. Engine coolant in the transmission hydraulic system requires immediate action to prevent malfunction and possible serious damage. An authorized Allison service outlet must completely disassemble, inspect, and clean the transmission. All traces of the coolant, and varnish deposits resulting from engine coolant contamination must be removed. Friction clutch plates contaminated with engine coolant (ethylene glycol) must be replaced.

Metal. Metal particles in the fluid (except for the minute particles normally trapped in the oil filter) indicate internal transmission damage. If these particles are found in the sump, the transmission must be disassembled and closely inspected to find their source. Metal contamination requires complete transmission disassembly. Clean all internal and external hydraulic circuits, cooler, and all other areas where the particles could lodge.

CAUTION: After flushing the cooler, be sure to check cooler circuit restriction. If circuit pressure drop is above specification, the cooler has excessive trapped particles and must be replaced. Excessive pressure drop impedes transmission cooling which can cause overheating and transmission damage.

TRANSMISSION FLUID AND FILTER CHANGE PROCEDURE

Drain Fluid.

NOTE: Do not drain the transmission fluid if only filters are being replaced.

WARNING: Avoid contact with the hot fluid or the sump when draining transmission fluid. Direct contact with the hot fluid or the hot sump may result in bodily injury.

1. Drain the fluid when the transmission is at operating temperature of 71–93°C (160–200°F). Hot fluid flows quicker and drains more completely.
2. Remove the drain plug from the control module and allow the fluid to drain into a suitable container.
3. Examine the fluid as described in the paragraph.

Replace Filters (Refer to Figure 12).

1. Remove twelve bolts (1), two filter covers (2), two gaskets (3), two O-rings (4), two O-rings (5), and two filters (6) from the bottom of the control module.
2. When reinstalling parts, lubricate and install new O-rings (4) and (5) on each cover (2). Lubricate O-ring inside filter (6) and push filter onto each cover (2). Install new gasket (3) on each cover (2) and align holes in gasket with holes in cover.

CAUTION: Do not use the bolts to draw the filter covers to the control module. Do not use an impact wrench to tighten the bolts. Using an impact wrench to tighten the bolts can strip threads and cause expensive parts replacement. Use a torque wrench to tighten the bolts.

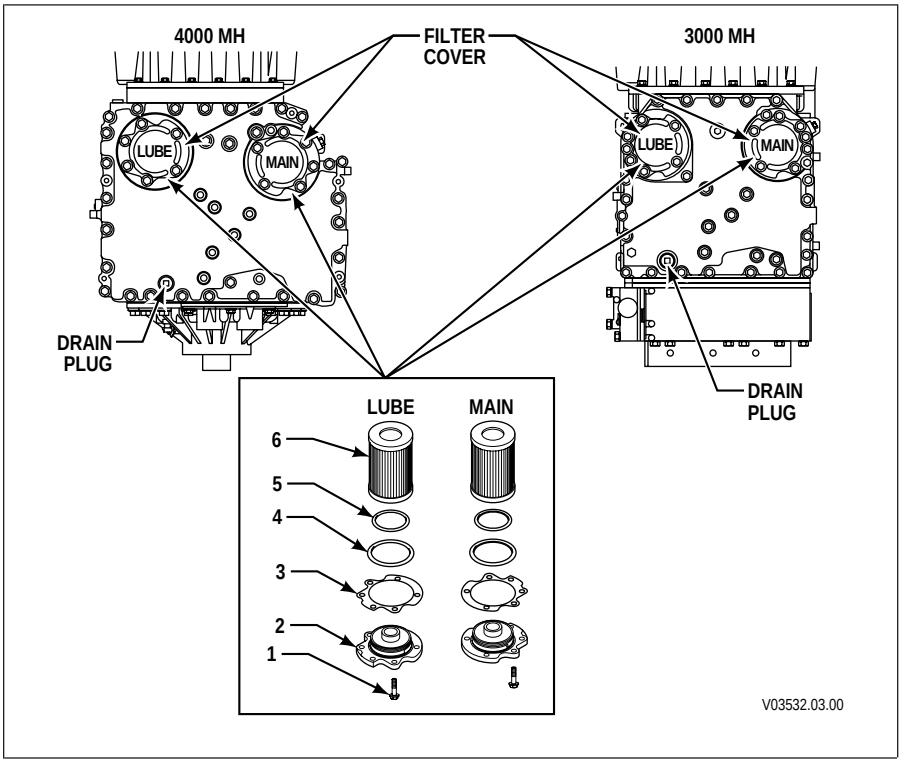


Figure 12. Location of Filters for Service

3. Install filter and cover assemblies into the filter compartment. Align each filter/cover assembly with the holes in the channel plate/sump. Push the cover assemblies in by hand to seat the seals.
4. Install six bolts into each cover and tighten to 51–61 N•m (38–45 lb ft).
5. Replace the drain plug O-ring. Install the plug and tighten to 25–32 N•m (18–24 lb ft).

Refill Transmission. The amount of refill fluid is less than the amount used for the initial fill. Fluid remains in the external circuits and transmission cavities after draining the transmission. After refill, check the fluid level. Refer to FLUID LEVEL CHECK USING PUSHBUTTON OR LEVER SHIFT SELECTOR paragraph.

NOTE: Quantities listed are approximations and do not include external lines and cooler hose.

Transmission Fluid Capacity

		Initial Fill		Refill	
Transmission	**Sump**	**Liters**	**Quarts**	**Liters**	**Quarts**
3000 MH	4 inch	27	29	18	19
	2 inch	25	26	16	17
4000 MH*	4 inch	45	48	37	39
	2 inch	38	40	30	31
* Add 2.8 Liters (3 Quarts) for transmissions with PTO.					

MOTORHOME SERIES

DIAGNOSTICS

INTRODUCTION

Continued illumination of the **CHECK TRANS** light during vehicle operation (not start-up) indicates the TCM/ECU has signaled a diagnostic code. Poor performance may activate a code without illuminating the **CHECK TRANS** light. Up to five diagnostic codes can be recorded. Diagnostic codes can be read and cleared by two methods: by using the shift selectors shown below or using the Allison DOC™ For PC–Service Tool. Use of the Allison DOC™ For PC–Service Tool is described in GN3433EN, User Guide, furnished with each tool. Basic information on code reading, code clearing and troubleshooting is covered in this DIAGNOSTICS section. For additional information, refer to TS3989EN Troubleshooting Manual for Allison 4th Generation Controls. More detailed information is available in the Troubleshooting Manual. Refer to the SERVICE LITERATURE section for the appropriate publication number.

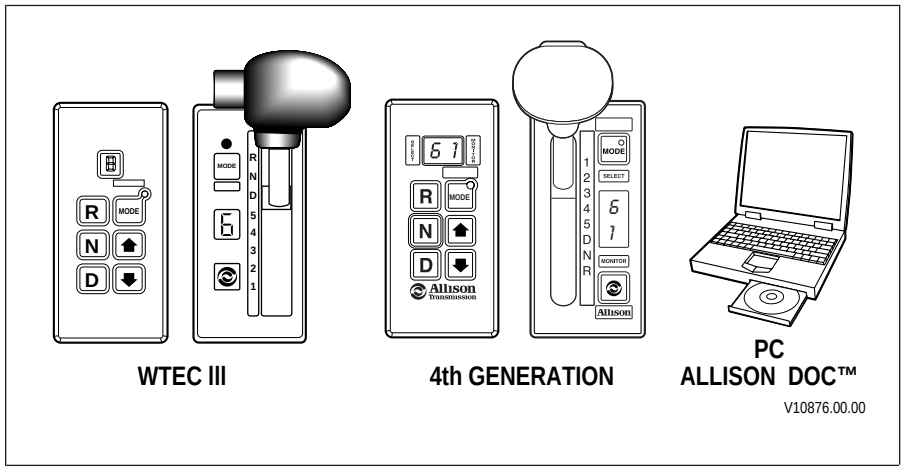


Figure 13. Shift Selector/Allison DOC™ Diagnostic Tool

DIAGNOSTIC CODES

Overview. Diagnostic codes are numerical indications relating to a malfunction in transmission operation. In WTEC III Controls, each code consists of a two-digit main code and a two-digit subcode. In Allison 4th Generation Controls, each code consists of five characters. The first character is a letter followed by a four digit numeric string. These codes are logged in a list in the TCM/ECU memory with the most severe or otherwise most recent code listed first. A maximum of five codes (numbered d1–d5) may be listed in memory at one time. As codes are added, the oldest non-active code is dropped from the list. If all codes are active, the code with the lowest priority that is not included on the severity list is dropped from the list. Access to the diagnostic codes and code information is through the pushbutton and lever shift selectors or the diagnostic data reader.

The TCM/ECU separately stores the active and historical (non-active) codes. An active code is any code that is current in the TCM/ECU decision-making process. Historical codes are codes that are retained in the TCM/ECU memory and will not necessarily affect the TCM/ECU decision-making process. Historical codes are useful in determining if a problem:

- Is isolated.
- Is intermittent.
- Results from a previous malfunction.

The TCM/ECU may automatically delete a code from memory if it has not recurred.

If the MODE INDICATOR (LED) is illuminated, the displayed code is active. If the MODE INDICATOR (refer to Figure 5 and Figure 6) is not illuminated, the displayed code is not active. An illuminated MODE INDICATOR during normal operation signifies secondary mode operation.

Diagnostic Codes—WTEC III Controls. When the diagnostic mode is entered, the first code (position d1) is displayed as follows:

Example—Code 1312:
Displayed as: **d, 1, 1, 3, 1, 2** (each item appears for about one second)

- d1 (code position)—Code position indicates that this is the first diagnostic code listed in the ECU memory.
- 13 (main code)—Main codes (2 digits displayed one-at-a-time) are listed first and provide the general condition or area of a fault detected by the ECU.
- 12 (subcode)—Subcode (2 digits displayed one-at-a-time) are listed second and provide specific areas or conditions within the main code that cause the fault. This subcode indicates the problem is caused by low voltage.

Diagnostic Codes—Allison 4th Generation Controls. When the diagnostic mode is entered, the first code (position d1) is displayed as follows:

Example—Code P0722:
Displayed as: **d1, P, 07, 22**
The code list position is the first item displayed, followed by the DTC. Each item is displayed for about one second. The display cycles continuously until the next code list position is accessed by pressing the **MODE** button. The following example shows how DTC P0722 is displayed on the pushbutton and lever shift selectors.

SELECT	MONITOR
d	1
	P
0	7
2	2

- d1 (code list position)—The position which a code occupies in the code list. Positions are displayed as “d1” through “d5” (Code List Position 1 through Code List Position 5).
- P0722 (DTC)—The diagnostic trouble code number referring to the general condition or area of fault detected by the TCM.

DIAGNOSTIC CODE DISPLAY PROCEDURE

Diagnostic codes can be read and cleared by two methods:

- Using an Allison DOC™ For PC–Service Tool. For specific instructions on how to use an Allison DOC™ For PC–Service Tool, refer to the User Guide.
- Using the pushbutton or lever shift selector.

Pushbutton Shift Selector. *To begin the Diagnostic Process:*

1. Bring the vehicle to a stop at a safe location.
2. Apply the parking brake.

To Display Stored Codes (refer to Figure 5 for WTEC III or Figure 6 for Allison 4th Generation shift selector):

1. Simultaneously press the ↑ (Up) and ↓ (Down) arrow buttons once to access the Oil Level Display Mode—press the buttons a second time to access the Diagnostic Display Mode.
2. Observe the digital display for codes.
   — Diagnostic codes will appear one digit at a time on WTEC III pushbutton or lever shift selectors.
   — Diagnostic codes will appear two characters at a time on Allison 4th Generation Controls pushbutton or lever shift selectors.
3. Press the **MODE** button to see the next code—repeat for subsequent codes.

NOTE: Be sure to record all codes displayed before they are cleared. This is essential for troubleshooting.

To Clear Active Indicators and Inactive Codes then Resume Vehicle Operation:

1. Clear active indicators and inactive codes.
   — WTEC III Controls—To clear active indicators such as the **CHECK TRANS** light, press and hold the **MODE** button for approximately three seconds until the MODE INDICATOR (LED) flashes. Release the **MODE** button and active indicators will not be illuminated. To clear inactive codes, press and hold the **MODE** button for 10 seconds. Some codes are self-clearing and others require ignition cycles to clear.
   — Allison 4th Generation Electric Controls—Press and hold the **MODE** button for 10 seconds to clear both active indicators and inactive codes.
2. Begin operating as normal—have the transmission checked at the earliest opportunity by an Allison Transmission distributor or dealer.

Lever Shift Selector. *To Begin the Diagnostic Process:*

1. Bring the vehicle to a stop at a safe location.
2. Apply the parking brake.

To Display Stored Codes (refer to Figure 5 for WTEC III or Figure 6 for Allison 4th Generation shift selector):

1. Press the **DISPLAY MODE/DIAGNOSTIC** button once to access the diagnostic display mode—press the button twice if a transmission oil level sensor is installed.
2. Observe the digital display for codes.
   - — Diagnostic codes will appear one digit at a time on WTEC III pushbutton or lever shift selectors.
   - — Diagnostic codes will appear two characters at a time on Allison 4th Generation Controls pushbutton or lever shift selectors.
3. Press the **MODE** button to see the next code—repeat for subsequent codes.

NOTE: Be sure to record all codes displayed before they are cleared. This is essential for troubleshooting.

To Clear Active Indicators and Inactive Codes then Resume Vehicle Operation:

1. Clear active indicators and inactive codes.
   - — WTEC III Controls—To clear active indicators such as the **CHECK TRANS** light, press and hold the **MODE** button for approximately three seconds until the MODE INDICATOR (LED) flashes. Release the **MODE** button and active indicators will not be illuminated. To clear inactive codes, press and hold the **MODE** button for 10 seconds. Some codes are self-clearing and others require ignition cycles to clear.
   - — Allison 4th Generation Electric Controls—Press and hold the **MODE** button for 10 seconds to clear both active indicators and inactive codes.
2. Begin operating as normal—have the transmission checked at the earliest opportunity by an Allison Transmission distributor or dealer.

NOTE: If the condition that caused the code is still present, the code will again become active.

DIAGNOSTIC CODE LISTINGS AND PROCEDURES (WTEC III CONTROLS)

The following table presents information about the diagnostic codes which may occur during the operation of the transmission. For additional information, refer to TS2973EN Troubleshooting Manual for WTEC III Controls.

Code Listings And Procedures (WTEC III Controls)

CODES		QUICK CHECKS
MAIN CODE	**SUB CODE**	
13	12	Check: a. Battery direct ground and power connections are tight and clean. b. Vehicle batteries are charged. c. Vehicle charging system is not over- or under-charging. d. VIM fuse is good. e. VIM connections are tight, clean, and undamaged. f. Vehicle manufacturer supplied wiring is correct. g. ECU connectors are tight, clean, and undamaged.
ECU Input Voltage Low		
13	13	
ECU Input Voltage Medium Low		
13	23	
ECU Input Voltage High		
14	12, 23	Check: a. Is transmission equipped with oil level sensor? b. Engine speed sensor, output speed sensor, temperature sensor, and oil level sensor are working correctly. c. Wiring harness has no opens, shorts-to-ground, or shorts-to-battery.
Oil Level Sensor		
21	12, 23	Check: a. TPS connector is properly connected. b. End of TPS cable is pulled out properly. c. Engine fuel lever is in idle position. d. Engine fuel lever provides proper amount of stroke on TPS cable. e. Wiring harness to TPS has no opens, shorts-between-wires, or shorts-to-ground. f. TPS for proper operation and resistance readings.
Throttle Position Sensor		

Code Listings And Procedures (WTEC III Controls) *(cont'd)*

CODES		QUICK CHECKS
MAIN CODE	**SUB CODE**	
22	14, 15, 16	Check: a. Speed sensors and connectors are tight, clean, and undamaged. b. Wiring harness to sensors has no opens, shorts-between-wires, or shorts-to-ground.
Speed Sensors		
23	12, 13, 14, 15, 16	Check: a. ECU connectors are tight, clean, and undamaged. b. Shift selector connector is tight, clean, and undamaged. c. Wiring harness has no opens, shorts-between-wires, or shorts-to-ground. d. Shift selector(s) for proper operation.
Shift Selectors		
24	12	Check: a. Air temperature is below –32°C (–25°F) • If yes, this is a correct response for temperature. • If no, check that main transmission connector is tight, clean, and undamaged. b. ECU connectors are tight, clean, and undamaged.
Sump Fluid Temperature Cold		
24	23	Verify the overheat situation. Check: a. Correct dipstick is installed. b. Fluid level is correct. Refer to CARE AND MAINTENANCE section. • If fluid level is incorrect—correct fluid level. • If fluid level is correct—check for cause of overheating. c. Check if ECU and transmission connectors are tight, clean, and undamaged.
Sump Fluid Temperature Hot		
25	00, 11, 22, 33, 44, 55, 66, 77	Check: a. Speed sensor connector is tight, clean, and undamaged. b. ECU connectors are tight, clean, and undamaged. c. Fluid level is correct. Refer to CARE AND MAINTENANCE section. d. Wiring harness to sensor has no opens, shorts-between-wires, or shorts-to-ground.
Output Speed Sensor		

Code Listings And Procedures (WTEC III Controls) *(cont'd)*

CODES		QUICK CHECKS
MAIN CODE	**SUB CODE**	
26	00, 11	Check: a. TPS for proper operation, related harness for opens and shorts. b. Serial connection to engine is tight, clean, and undamaged. c. SCI wiring harness has no opens or shorts.
Throttle/Engine Coolant Source Not Detected		
32	00, 33, 55, 77	Check: a. Correct dipstick is installed. b. Fluid level is correct. Refer to CARE AND MAINTENANCE section. c. Main transmission connector is tight, clean, and undamaged. d. ECU connectors are tight, clean, and undamaged. e. Wiring harness has no opens, shorts-between-wires, or shorts-to-ground.
C3 Pressure Switch Open		
33	12, 23	Check: a. Main transmission connector is tight, clean, and undamaged. b. ECU connectors are tight, clean, and undamaged. c. Wiring harness has no opens, shorts-between-wires, or shorts-to-ground.
Sump Oil Temperature Sensor Failure		
34	12, 13, 14, 15, 16, 17	a. Recalibrate ECU, if possible. b. Replace ECU if not possible to recalibrate.
EEPROM		
35	00, 16	Check: a. ECU connectors are tight, clean, and undamaged. b. VIM connectors are tight, clean, and undamaged. c. Vehicle manufacturer supplied wiring has correct power and ground connections. d. Power connections are battery direct. e. Ground connections are battery direct. f. Ignition switch connections are correct.
Power Interruption Real Time Write Interruption		

Code Listings And Procedures (WTEC III Controls) *(cont'd)*

CODES		QUICK CHECKS
MAIN CODE	**SUB CODE**	
36	00, 01, 02	a. If able, recalibrate ECU; if not, replace ECU. b. Check that ECU is compatible with TransID level (36 01). c. Troubleshoot TransID wire and circuit for short-to-battery (36 02).
Hardware/Software Not Compatible		
42	12, 13, 14, 15, 16, 21 22, 23, 24, 26	Check: a. Main transmission connector is tight, clean, and undamaged. b. ECU connectors are tight, clean, and undamaged. c. Wiring harness is not pulled too tight, and there is no damage, chafing, or screws through harness. d. Wiring harness has no opens, shorts-between-wires, or shorts-to-ground. e. Unauthorized repairs have not been made. f. Change harness (optional).
Short-to-Battery in Solenoid Circuit		
44	12, 13, 14, 15, 16, 21, 22, 23, 24, 26	Check: a. Main transmission connector is tight, clean, and undamaged. b. ECU connectors are tight, clean, and undamaged. c. Wiring harness has no opens, shorts-between-wires, or shorts-to-ground.
Solenoid Circuit Short-to-Ground		
45	12, 13, 14, 15, 16, 21, 22, 23, 24, 26	Check: a. Main transmission connector is tight, clean, and undamaged. b. ECU connectors are tight, clean, and undamaged. c. Wiring harness has no opens or shorts.
Solenoid Circuit Open		
46	21, 26, 27	Check: a. Main transmission connector is tight, clean, and undamaged. b. ECU connectors are tight, clean, and undamaged. c. Wiring harness has no opens, shorts-between-wires, or shorts-to-ground. d. Replace ECU.
Solenoid Overcurrent		

Code Listings And Procedures (WTEC III Controls) *(cont'd)*

CODES		QUICK CHECKS
MAIN CODE	**SUB CODE**	
51	01, 10, 12, 21, 23, 24, 35, 42, 43, 45, 46, 53, 64, 65, XY*	Check: a. Output and turbine speed sensor connectors are tight, clean, and undamaged. b. Speed sensor wiring harness has no opens, shorts-between-wires, or shorts-to-ground. c. Correct dipstick is installed. d. Fluid level is correct. Refer to CARE AND MAINTENANCE section.
Off-going Ratio Test (During Shift)		
52	01, 08, 32, 34, 54, 56, 71, 72, 78, 99, XY*	Check: a. Output and turbine speed sensor connectors are tight, clean, and undamaged. b. Speed sensor wiring harness has no opens, shorts-between-wires, or shorts-to-ground. c. Main wiring harness to transmission has no shorts-between-wires or shorts-to-ground. d. Correct dipstick is installed. e. Fluid level is correct. Refer to CARE AND MAINTENANCE section.
Off-going C3 Pressure Switch Test (During Shift)		
53	08, 09, 18, 19, 28, 29, 38, 39, 48, 49, 58, 59, 68, 69, 78, 99, XY*	Check: a. Turbine and engine speed sensor connectors are tight, clean, and undamaged. b. Speed sensor wiring harness has no opens, shorts-between-wires, or shorts-to-ground. c. Correct dipstick is installed. d. Fluid level is correct. Refer to CARE AND MAINTENANCE section.
Off-going Speed Test (During Shift)		
*Additional codes could be logged for other shifts where X indicates range shifted from and Y indicates range shifted to.		

Code Listings And Procedures (WTEC III Controls) *(cont'd)*

CODES		QUICK CHECKS
MAIN CODE	**SUB CODE**	
54	01, 07, 10, 12, 17, 21, 23, 24, 27, 32, 34, 35, 42, 43, 45, 46, 53, 54, 56, 64, 65, 70, 71, 72, 80, 81, 82, 83, 85, 86, 87, 92, 93, 95, 96, XY*	Check: a. Turbine and output speed sensor connectors are tight, clean, and undamaged. b. Speed sensor wiring harness has no opens, shorts-between-wires, or shorts-to-ground. c. Correct dipstick is installed. d. Fluid level is correct. Refer to CARE AND MAINTENANCE section. e. EEPROM calibration is correct for the transmission.
Oncoming Ratio Test (After Shift)		
55	07, 17, 27, 87, 97, XY*	Check: a. Correct dipstick is installed. b. Fluid level is correct. Refer to CARE AND MAINTENANCE section. c. Output and turbine speed sensor connectors are tight, clean, and undamaged. d. Speed sensor wiring harness has no opens, shorts-between-wires, or shorts-to-ground. e. Transmission connector is tight, clean, and undamaged. f. ECU connectors are tight, clean, and undamaged. g. C3 pressure switch wiring has no opens, shorts-between-wires, or shorts-to-ground.
Oncoming C3 Pressure Switch Test (After Shift)		
*Additional codes could be logged for other shifts where X indicates range shifted from and Y indicates range shifted to.		

Code Listings And Procedures (WTEC III Controls) *(cont'd)*

CODES		QUICK CHECKS
MAIN CODE	**SUB CODE**	
56	00, 11, 22, 33, 44, 55, 66, 77	Check: a. Turbine and output speed sensor connectors are tight, clean, and undamaged. b. Speed sensor wiring harness has no opens, shorts-between-wires, or shorts-to-ground. c. Transmission connector is tight, clean, and undamaged. d. ECU connectors are tight, clean, and undamaged. e. Correct dipstick is installed. f. Fluid level is correct. Refer to CARE AND MAINTENANCE section.
Range Verification Ratio Test		
57	11, 22, 44, 66, 88, 99	Check: a. Correct dipstick is installed. b. Fluid level is correct. Refer to CARE AND MAINTENANCE section. c. Output and turbine speed sensor connectors are tight, clean, and undamaged. d. Speed sensor wiring harness has no opens, shorts-between-wires, or shorts-to-ground. e. Transmission connector is tight, clean, and undamaged. f. ECU connectors are tight, clean, and undamaged. g. C3 pressure switch wiring has no opens, shorts-between-wires, or shorts-to-ground.
Range Verification C3 Pressure Switch Test		
61	00	Check: a. Fluid level is correct. Refer to CARE AND MAINTENANCE section. b. Retarder apply system is not allowing retarder and throttle to be applied at the same time. c. Fluid cooler is adequately sized for load.
Retarder Over Temperature		

Code Listings And Procedures (WTEC III Controls) *(cont'd)*

CODES		QUICK CHECKS
MAIN CODE	**SUB CODE**	
62	12, 23, 32, 33	Check: a. Retarder temperature measured with diagnostic tool is consistent with code; or determine if code is active using shift selector. b. Sensor connector is tight, clean, and undamaged. c. ECU connectors are tight, clean, and undamaged. d. Temperature sensor circuit has no opens, shorts-between-wires, or shorts-to-ground. e. Serial connection to engine computer is tight, clean, and undamaged. f. SCI wiring harness has no opens or shorts.
Retarder Temperature Sensor, Engine Coolant Sensor		
63	00, 26, 40, 41, 47	Check input wiring, switches, and connectors to determine why input states are different.
Input Function Fault		
64	12, 23	Use diagnostic tool to read retarder counts and identify problem wires. Check wiring for short-to-battery, ground wire open, or short-to-ground.
Retarder Modulation Request Device Fault		
66	00, 11, 22	Check: a. b. c. a. Serial connection to engine computer is tight, clean, and undamaged. b. SCI wiring harness has no opens, shorts, or shorts-to-ground. c. If diagnostic tool is not available, also be sure that transmission ECU connections are tight, clean, and undamaged. d. Problem with CAN link or engine controls.
Serial Communications Interface Fault		
69	27, 28, 29, 33, 34, 35, 36, 39, 41, 42, 43	a. Clear diagnostic code and retry vehicle start. b. If code recurs, reprogram or replace ECU.
ECU Malfunction		
70	12, 13, 14	Reset ECU
Software Problem		

DIAGNOSTIC CODE LISTINGS AND PROCEDURES (ALLISON 4th GENERATION CONTROLS)

The following table presents information about the diagnostic codes which may occur during the operation of the transmission. For additional information, refer to TS3989EN Troubleshooting Manual for Allison 4th Generation Controls.

Code Listings And Procedures (Allison 4th Generation Controls)

CODES	QUICK CHECKS
C1312, C1313 **Retarder Request Sensor Fault**	Use an Allison DOC™ diagnostic tool to read Retarder Request Percentage. Check wiring for short-to-battery, ground wire open, or short-to-ground.
P0122, P0123 **Pedal Position Sensor Fault**	Check: a. TPS connector is properly connected. b. End of TPS cable is pulled out properly. c. Engine fuel lever is in idle position. d. Engine fuel lever provides proper amount of stroke on TPS cable. e. Wiring harness to TPS has no opens, shorts-between-wires, or shorts-to-ground. f. TPS for proper operation and resistance readings.
P0218 **Transmission Over Temperature**	Verify the overheat situation and check: Correct dipstick is installed. Proper fluid level. Refer to CARE AND MAINTENANCE section. i. If fluid level is incorrect—correct the fluid level. ii. If fluid level is correct—check for the cause of overheating. Check that the TCM and transmission connectors are tight, clean, and undamaged.
P0602 **TCM Not Programmed**	Recalibrate the TCM. If unable to recalibrate, replace the TCM.
P0610 **TCM Vehicle Options Error**	Update TCM calibration to match transmission configuration.
P0613 **TCM Processor**	Contact Allison Transmission Technical Assistance Center at: 1-800-252-5283.

Code Listings And Procedures
(Allison 4th Generation Controls) *(cont'd)*

CODES	QUICK CHECKS
P0614 **Torque Control Data Mismatch— TCM/ECM**	Check: a. Data link communication connectors at engine and transmission controllers are tight, clean, and undamaged. b. Data link communications wiring harness has no opens, shorts, or shorts-to-ground. — The resistance between J1939 CAN high and CAN low wires should be 60 Ohms. c. No unauthorized engine power updates were made. Update engine software to be compatible with transmission torque requirements: a. Add necessary engine torque control functions, or b. Reduce engine power and torque ratings.
P0634 **TCM Internal Temperature Too High**	Check: a. High temperature components such as exhaust lines in the vicinity of the TCM. Shield or relocate TCM, if appropriate.
P063E **Auto Configuration Throttle Input Not Present**	Check: a. Data link communication connectors at engine and transmission controllers are tight, clean, and undamaged. b. Data link communications wiring harness has no opens, shorts, or shorts-to-ground. — The resistance between J1939 CAN high and CAN low wires should be 60 Ohms c. TPS (if installed) for proper operation, related harness for opens and shorts.
P063F **Auto Configuration Engine Coolant Not Present**	Check: a. Data link communication connectors at engine and transmission controllers are tight, clean, and undamaged. b. Data link communications wiring harness has no opens, shorts, or shorts-to-ground. — The resistance between J1939 CAN high and CAN low wires should be 60 Ohms. — Engine coolant temp sensor harness for opens and shorts.

Code Listings And Procedures
(Allison 4th Generation Controls) *(cont'd)*

CODES	QUICK CHECKS
P0658, P0659, P2670, P2671, P2685, P2686 **Actuator Supply Voltage Fault**	Check: a. Main transmission connector is tight, clean, and undamaged. b. TCM connector is tight, clean, and undamaged. c. Wiring harness has no opens, shorts-between-wires, or shorts-to-ground.
P0702 **Transmission Control System Electrical**	Check: a. Main transmission connector is tight, clean, and undamaged. b. TCM connector is tight, clean, and undamaged. c. Wiring harness has no opens, shorts-between-wires, or shorts-to-ground.
P0703 **Brake Switch Circuit**	Check: a. Brake pressure switch, wiring, and connectors to determine why brake input is not being sent to the TCM.
P0708 **Transmission Range Sensor Circuit**	Check: a. TCM connector is tight, clean, and undamaged. b. Strip-type shift selector connector is tight, clean, and undamaged. c. Wiring harness has no opens, shorts-between-wires, or shorts-to-ground. Strip-type shift selector for proper operation.
P070C, P070D **Transmission Fluid Level Sensor Fault**	Check: a. Is the transmission equipped with an oil level sensor? b. Engine speed sensor, output speed sensor, temperature sensor, and oil level sensor working correctly. c. Wiring harness has no opens, shorts-between-wires, or shorts-to-ground.
P0711, P0712, P0713 **Transmission Fluid Temperature Circuit Fault**	Check: a. Correct fluid level. b. Main transmission connector is tight, clean, and undamaged. c. TCM connector is tight, clean, and undamaged. d. Wiring harness has no opens, shorts-between-wires, or shorts-to-ground.

Code Listings And Procedures
(Allison 4th Generation Controls) *(cont'd)*

CODES	QUICK CHECKS
P0716, P0717, P0721, P0722, P0726, P0727 **Speed Sensor Circuit Fault**	Check: a. Speed sensors and connectors are tight, clean, and undamaged. b. Wiring harness has no opens, shorts-between-wires, or shorts-to-ground.
P0719 **Brake Switch ABS Input Circuit Fault**	Check input wiring, switches, and connectors to determine why ABS input is not being sent to the TCM.
P071A **RELS Input Fault**	Check brake pressure switch, wiring, and connectors to determine why RELS input is not being sent to the TCM.
P071D **General Purpose Input Fault**	Check input wiring, switches, and connectors to determine why input states are different.
P0729, P0731, P0732, P0733, P0734, P0735, P0736 **Incorrect Gear Ratio**	Check: a. Turbine and output speed sensor connectors are tight, clean, and undamaged. b. Speed sensor wiring harness has no opens, shorts-between-wires, or shorts-to-ground. c. Wiring harness has no opens, shorts-between-wires, or shorts-to-ground. Let vehicle idle with parking brake applied, wheels chocked, and vehicle level. Check: a. Correct dipstick is installed. b. Fluid level is correct. TCM calibration is correct for transmission model.
P0741 **Torque Converter Clutch System Stuck OFF**	Check: a. Engine and turbine speed sensor connectors are tight, clean, and undamaged. b. Speed sensor wiring harness has no opens, shorts-between-wires, or shorts-to-ground. c. Wiring harness has no opens, shorts-between-wires, or shorts-to-ground. Let vehicle idle with parking brake applied, wheels chocked, and vehicle level. Check: a. Correct dipstick is installed. b. Fluid level is correct.

Code Listings And Procedures
(Allison 4th Generation Controls) *(cont'd)*

CODES	QUICK CHECKS
P0776, P0796, P2714, P2723 **Pressure Control Solenoid Controlled Clutch Stuck OFF**	Check: a. Turbine and output speed sensor connectors are tight, clean, and undamaged. b. Speed sensor wiring harness has no opens, shorts-between-wires, or shorts-to-ground. Let vehicle idle with parking brake applied, wheels chocked, and vehicle level. Check: a. Correct dipstick is installed. b. Fluid level is correct.
P0777, P0797, P2715, P2724 **Pressure Control Solenoid Controlled Clutch Stuck ON**	Check: a. Turbine and output speed sensor connectors are tight, clean, and undamaged. b. Speed sensor wiring harness has no opens, shorts-between-wires, or shorts-to-ground. Let the vehicle idle with the parking brake applied, wheels chocked, and vehicle level. Check: a. Correct dipstick is installed. b. Fluid level is correct.
P0842, P0843 **Transmission Pressure Switch Solenoid 1 Circuit Fault**	Let the vehicle idle with the parking brake applied, wheels chocked, and vehicle level. Check: a. Correct dipstick is installed. b. Fluid level is correct. Check: a. Main transmission connector is tight, clean, and undamaged. b. TCM connector is tight, clean, and undamaged. c. PS1 diagnostic pressure switch has no opens, shorts-between-wires, or shorts-to-ground.
P0880, P0881, P0882, P0883 **TCM Power Input Signal Fault**	Check: a. Battery direct ground and power connections are tight and clean. b. Vehicle batteries are charged. c. Vehicle charging system is not over- or under-charging. d. VIM fuse is good. e. VIM connections are tight, clean, and undamaged. f. Vehicle manufacturer supplied wiring is correct. g. TCM connection is tight, clean, and undamaged.

Code Listings And Procedures
(Allison 4th Generation Controls) *(cont'd)*

CODES	QUICK CHECKS
P0894 **Transmission Component Slipping**	Let the vehicle idle with the parking brake applied, wheels chocked, and vehicle level. Check: a. Correct dipstick is installed. b. Fluid level is correct.
P0960, P0964, P0968, P2727, P2736, P2761 **Pressure Control Solenoid Circuit Open**	Check: a. Main transmission connector is tight, clean, and undamaged. b. TCM connector is tight, clean, and undamaged. c. Wiring harness has no opens.
P0962, P0966, P0970, P2720, P2729, P2738, P2764 **Pressure Control Solenoid Circuit Low**	Check: a. Main transmission connector is tight, clean, and undamaged. b. TCM connector is tight, clean, and undamaged. c. Wiring harness has no shorts-between-wires or shorts-to-ground.
P0963, P0967, P0971, P2721, P2730, P2739, P2763 **Pressure Control Solenoid Circuit High**	Check: a. Main transmission connector is tight, clean, and undamaged. b. TCM connector is tight, clean, and undamaged. c. Wiring harness has no shorts-between-wires.
P0973, P0976 **Shift Solenoid Circuit Low**	Check: a. Main transmission connector is tight, clean, and undamaged. b. TCM connector is tight, clean, and undamaged. c. Wiring harness has no opens, shorts-between-wires, or shorts-to-ground.
P0974, P0977 **Shift Solenoid Circuit High**	Check: a. Main transmission connector is tight, clean, and undamaged. b. TCM connector is tight, clean, and undamaged. c. Wiring harness has no shorts-between-wires.

Code Listings And Procedures
(Allison 4th Generation Controls) *(cont'd)*

CODES	QUICK CHECKS
P0975 **Shift Solenoid Circuit Open**	Check: a. Main transmission connector is tight, clean, and undamaged. b. TCM connector is tight, clean, and undamaged. c. Wiring harness has no opens.
P0989, P0990 **Retarder Pressure Sensor Circuit Fault**	Check: a. Retarder pressure sensor connector is tight, clean, and undamaged. b. TCM connector is tight, clean, and undamaged. c. Retarder pressure circuit has no opens, shorts-between-wires, or shorts-to-ground.
P1891, P1892 **Throttle Position PWM Signal Circuit Fault**	Check: a. PWM throttle position sensor connector is tight, clean, and undamaged. b. TCM connector is tight, clean, and undamaged. c. PWM throttle position sensor circuit has no opens, shorts-between-wires, or shorts-to-ground.
P2184, P2185 **Engine Coolant Temp Sensor Circuit Fault**	Check: a. Engine coolant temperature sensor connector is tight, clean, and undamaged. b. TCM connector is tight, clean, and undamaged. c. Engine coolant temperature sensor circuit has no opens, shorts-between-wires, or shorts-to-ground.
P2637, P2641 **Torque Management Feedback Signal Fault**	Check that no unauthorized engine power upgrades were made. Check that engine software is compatible with transmission torque requirements, otherwise: a. Recalibrate engine controller with compatible software, or b. Reduce engine power and torque ratings.
P2740 **Retarder Oil Temperature Hot**	Check: a. Transmission fluid level is correct. b. Retarder apply system is not allowing retarder and throttle to be applied at the same time. c. Vehicle manufacturer's transmission oil cooler is adequately sized for heat load.

Code Listings And Procedures
(Allison 4th Generation Controls) *(cont'd)*

CODES	QUICK CHECKS
P2742, P2743 **Retarder Oil Temperature Sensor Circuit Fault**	Check: a. Retarder temperature measured with Allison DOC™ diagnostic tool is consistent with code, or determine if code is active using the shift selector. b. Retarder temperature sensor connector is tight, clean, and undamaged. c. TCM connector is tight, clean, and undamaged. d. Temperature sensor circuit has no opens, shorts-between-wires, or shorts-to-ground.
P278A **Kickdown Switch Circuit**	Check input wiring, switches, and connectors to determine why kickdown input is not being sent to the TCM.
P2793 **Gear Shift Direction Circuit**	Check: a. Shift selector connector is tight, clean, and undamaged. b. TCM connector is tight, clean, and undamaged. c. Gear shift direction circuit has no opens, shorts-between-wires, or shorts-to-ground.
U0001 **High Speed CAN Bus Reset Counter Overrun**	Check: a. High speed CAN connectors at engine and transmission controllers are tight, clean, and undamaged. b. High speed CAN wiring harness has no opens, shorts-between-wires, or shorts-to-ground. — The resistance between the CAN high and CAN low wires should be 60 Ohms.
U0010 **CAN Bus Reset Counter Overrun**	Check: a. J1939 CAN connectors at engine and transmission controllers are tight, clean, and undamaged. b. J1939 CAN wiring harness has no opens, shorts-between-wires, or shorts-to-ground. — The resistance between the CAN high and CAN low wires should be 60 Ohms.
U0100 **Lost Communications with ECM/TCM (J1587)**	Check: a. Serial communications interface connections at engine are tight, clean, and undamaged. b. TCM connector is tight, clean, and undamaged. c. Serial communication interface wiring harness has no opens, shorts-between-wires, or shorts-to-ground.

Code Listings And Procedures
(Allison 4th Generation Controls) *(cont'd)*

CODES	QUICK CHECKS
U0103, U0291 **Lost Communications with Gear Shift Module (Shift Selector)**	Check: a. Shift selector connector is tight, clean, and undamaged. b. TCM connector is tight, clean, and undamaged. c. Shift selector wiring harness has no opens, shorts-between-wires, or shorts-to-ground.
U0115 **Lost Communications with ECM/TCM (J1939)**	Check: a. J1939 CAN connectors at engine and transmission controllers are tight, clean, and undamaged. b. J1939 CAN wiring harness has no opens, shorts-between-wires, or shorts-to-ground. — The resistance between the CAN high and CAN low wires should be 60 Ohms.
U0304, U0333 **Incompatible Gear Shift Module**	Check that the shift selector is an Allison supplied shift selector.
U0404, U0592 **Invalid Data Received from Gear Shift Module**	Check: a. Shift selector connector is tight, clean, and undamaged. b. TCM connector is tight, clean, and undamaged. c. Shift selector wiring harness has no opens, shorts-between-wires, or shorts-to-ground.

MOTORHOME SERIES

CUSTOMER SERVICE

OWNER ASSISTANCE

The satisfaction and goodwill of the owners of Allison transmissions are of primary concern to Allison Transmission, its distributors, and their dealers.

As an owner of an Allison transmission, you have service locations throughout the world that are eager to meet your parts and service needs with:

- Expert service by trained personnel.
- Emergency service 24 hours a day in many areas.
- Complete parts support.
- Sales teams to help determine your transmission requirements.
- Product information and literature.

Normally, any situation that arises in connection with the sale, operation, or service of your transmission will be handled by the distributor or dealer in your area. Check the telephone directory for the Allison Transmission service outlet nearest you or utilize Allison Transmission's Sales and Service Locator tool on the Allison Transmission web site at ***www.allisontransmission.com.*** You may also refer to Allison Transmission's Worldwide Sales and Service Directory (SA2229EN).

We recognize, however, that despite the best intentions of everyone concerned, misunderstandings may occur. To further assure your complete satisfaction, we have developed the following three-step procedure to be followed in the event a problem has not been handled satisfactorily.

Step One—Discuss your problem with a member of management from the distributorship or dealership. Frequently, complaints are the result of a breakdown in communication and can quickly be resolved by a member of management. If you have already discussed the problem with the Sales or Service Manager, contact the General Manager. All Allison Transmission dealers are associated with an Allison Transmission distributor. If the problem originates with a dealer, explain the matter to a management member of the distributorship with

whom the dealer has his service agreement. The dealer will provide his Allison Transmission distributor's name, address, and telephone number on request.

Step Two—When it appears the problem cannot be readily resolved at the distributor level without additional assistance, **contact the Allison Technical Assistance Center at 800-252-5283.** They will place you in contact with the Regional Customer Support Manager for your area.

For prompt assistance, please have the following information available:

- Name and location of authorized distributor or dealer.
- Type and make of vehicle/equipment.
- Transmission model number, serial number, and assembly number (if equipped with electronic controls, also provide the TCM assembly number).
- Transmission delivery date and accumulated miles and/or hours of operation.
- Nature of problem.
- Chronological summary of your transmission's history.

Step Three—If you are still not satisfied after contacting the Regional Customer Support Manager, **present the entire matter to the Home Office by writing to the following address:**

Allison Transmission
Manager, Warranty Administration
PO Box 894, Mail Code 462-470-PF9
Indianapolis, IN 46206-0894

The inclusion of all pertinent information will assist the Home Office in expediting the matter.

When contacting the Home Office, please keep in mind that ultimately the problem will likely be resolved at the distributorship or dealership using their facilities, equipment, and personnel. Therefore, it is suggested that **Step One** be followed when experiencing a problem.

Your purchase of an Allison Transmission product is greatly appreciated, and it is our sincere desire to assure complete satisfaction.

SERVICE LITERATURE

Additional service literature is available as shown in the service literature table. This service literature provides fully illustrated instructions for the operation, maintenance, service, overhaul, and parts support of your transmission. To be sure that you get maximum performance and service life from your unit, you may order publications from:

SGI, Inc.
Attn: Allison Literature Fulfillment Desk
8350 Allison Avenue
Indianapolis, IN 46268
TOLL FREE: 888-666-5799
INTERNATIONAL: 317-471-4995

Available Service Literature (WTEC III Controls)

Publication Type	3000	4000
Allison DOC™ For PC User Guide	GN3433EN	GN3433EN
Automatic Transmission Fluid Technician's Guide	GN2055EN	GN2055EN
Mechanic's Tips*	MT3004EN	MT3004EN
Parts Catalog*	PC2150EN	PC2456EN
Parts Catalog CD-ROM	CD2150EN	CD2456EN
Principles of Operation	PO2454EN	PO2454EN
Service Manual	SM2148EN	SM2457EN
Troubleshooting Manual	TS2973EN	TS2973EN
Worldwide Sales and Service Directory*	SA2229EN	SA2229EN
* Also available on the Allison Transmission web site at ***www.allisontransmission.com***		

Available Service Literature (Allison 4th Generation Controls)

Publication Type	3000	4000
Allison DOC™ For PC User Guide	GN3433EN	GN3433EN
Mechanic's Tips (except 3700 7-speed)*	MT4015EN	MT4015EN
Mechanic's Tips (7-speed)*	MT4108EN	NA
Parts Catalog*	PC2150EN	PC2456EN
Parts Catalog on CD	CD2150EN	CD2456EN
Principles of Operation	PO4016EN	PO4016EN
Service Manual	SM4013EN	SM4014EN
Troubleshooting Manual	TS3989EN	TS3989EN
Worldwide Sales and Service Directory*	SA2229EN	SA2229EN
* Also available on the Allison Transmission web site at ***www.allisontransmission.com***		

ALLISON TRANSMISSION DISTRIBUTORS

EASTERN REGION

Atlantic Detroit Diesel-Allison, LLC
190 Chapin Road
Pinebrook, NJ 07058
973-575-0309

Covington Power Services
8015 Piedmont Triad Parkway
Greensboro, NC 27409
336-292-9240

Johnson & Towers, Inc.
2021 Briggs Road
Mount Laurel, NJ 08054
856-234-6990

New England Detroit Diesel-Allison, Inc.
90 Bay State Road
Wakefield, MA 01880-1095
781-246-1810

Penn Detroit Diesel-Allison, Inc.
8330 State Road
Philadelphia, PA 19136-2986
215-335-0500

Western Branch Diesel, Inc.
3504 Shipwright Street
Portsmouth, VA 23703
757-673-7000

W.W. Williams S.E., Inc.
3077 Moreland Avenue
Conley, GA 30288
404-366-1070

CENTRAL REGION

Central Power Systems & Services, Inc.
9200 Liberty Drive
Liberty, MO 64068
816-781-8070

Clarke Power Services, Inc.
3133 East Kemper Road
Cincinnati, OH 45241
513-771-2200

Detroit Diesel-Allison Canada East
Div. of Integrated Power Systems Corp.
2997 Avenue Watt
Quebec, Quebec G1X 3W1
418-651-5371

Harper Power Products, Inc
10 Diesel Drive
Toronto, Ontario M8W 2T8
416-259-3281

Inland Diesel, Inc.
13015 West Custer Avenue
Butler, WI 53007-0916
262-781-7100

Interstate PowerSystems, Inc.
2501 American Boulevard, East
Minneapolis, MN 55425
952-854-5511

W.W. Williams M.W., Inc.
1176 Industrial Parkway, North
Brunswick, OH 44212-2342
330-225-7751

SOUTHERN REGION

Caribe Detroit Diesel-Allison
Division of GT Corporation
Ceramic Ind. Park
Campo Rico Ave., Block C
Carolina, Puerto Rico 00982
787-750-5000

Detroit Diesel-Allison de Mexico S.A. de C.V.
Av. Santa Rosa No. 58
Col. Ampliacion Norte
San Juan Ixtacala, Tlalnepantla
C.P. 54160, Estado de Mexico
525-5-5333-1800

Florida Detroit Diesel-Allison, Inc.
2277 N.W. 14th Street
Miami, FL 33125-0068
904-737-7330

Stewart & Stevenson Power Products, LLC
5170 East 58th Place
Commerce City, CO 80022
303-287-7441

Stewart & Stevenson Power Products, LLC
1000 Louisiana, Suite 4950
Houston, TX 77002
713-751-2600

United Engines, LLC
5555 West Reno Street
Oklahoma City, OK 73127
405-947-3321

WESTERN REGION

ABC Transmissions, Ltd
9357 – 193rd Street
Surrey, British Columbia V4N 4E7
604-888-1211

Pacific Power Products Company
7215 South 228th Street
Kent, WA 98032
253-854-0505

Smith Power Products, Inc.
3065 West California Avenue
Salt Lake City, UT 84104
801-415-5000

Valley Power Systems, Inc
425 South Hacienda Boulevard
City of Industry, CA 91745-1123
626-333-1243

Waterous Power Systems
(A Div. of Integrated Power Systems Corp.)
10025 – 51 Avenue
Edmonton, Alberta T6E OA8
780-437-3550

W.W. Williams S.W., Inc.
2602 S. 19th Avenue
Phoenix, AZ 85009
602-257-0561

ALLISON TRANSMISSION REGIONAL OFFICES

EASTERN REGION
19 Oaklynn Drive
PO Box 400
Columbus, NJ 08022-0400
609-298-2541

SOUTHERN REGION
Av. Ejercito Nacional No. 843
Colonia Granada
Mexico, D.F. C.P. 11520
936-321-4248

CENTRAL REGION
PO Box 894, Mail Code 462-470-PF06
Indianapolis, IN 46206-0894
317-242-2327

WESTERN REGION
2843 Hopyard Road #143
Pleasanton, CA 94588
925–698–5703

TABLE OF CONTENTS

SPICER LIFE SERIES™ DRIVESHAFT INSTALLATION

Before You Get Started

Note – Spicer Life Series driveshafts are found on vehicles throughout the world. Therefore, this manual includes worldwide terminology. These terms have been highlighted in teal.

Caution – Under no circumstances should individuals attempt to perform driveline service and/or maintenance procedures for which they have not been trained or do not have the proper tools and equipment. ▲ See warning, below.

▲ ***WARNING***

Failure to take commonsense, precautionary measures when working on a vehicle or other machinery could result in property damage, serious personal injury or death. In order to avoid property damage, serious personal injury or death, you must:

1. **ALWAYS** wear safety glasses when performing maintenance or service. Failure to wear safety glasses can result in personal injury and/or partial or complete vision loss.

2. **NEVER** go under a vehicle while the engine is running. Be sure the vehicle's engine is off, and keys are removed from ignition.

3. **NEVER** go under or work on a vehicle that is not on a level or flat surface.

4. **NEVER** work on a driveshaft without blocking the vehicle's wheels and releasing all parking brakes. ▲ See warning, below.

▲ ***WARNING***

Failure to release all parking brakes and placing transmission in neutral can result in torque being applied to the driveshaft. Disconnecting a driveshaft with applied torque can result in property damage, serious personal injury or death.

5. **NEVER** lift a vehicle without the appropriate weight-rated, vehicle-support equipment.

6. **NEVER REMOVE** a driveshaft from the vehicle without keeping the vehicle's transmission in neutral. ▲ See warning, step 4.

7. **CAUTION** – Spicer Life Series driveshaft assemblies can weigh in excess of 100 pounds (46 kilograms). Be sure to use proper lifting techniques when handling Spicer Life Series driveshafts. More than one person may be needed when handling driveshaft assemblies.

8. **ALWAYS** use support straps to prevent the driveshaft from falling out of vehicle during the removal and installation process.

9. **NEVER** heat components or use sledgehammers or floor jacks to remove the driveshaft from vehicle.

Note – For driveshaft applications that have pillow blocks, dampers, parking brakes or retarders, refer to these component manufacturers' or the original equipment vehicle manufacturers' service manuals for proper procedures.

SERVICING A SPICER LIFE SERIES DRIVESHAFT

The following components are serviceable:

- Universal Joint Kits
- Boot Kits
- Quick Disconnect™ End Yokes
- S.A.E., DIN and T-Type Flange Yokes
- S.A.E., DIN and T-Type Companion Flanges
- Bearing Retainers and Bolts or Stamped Straps and Bolts
- Spring Tabs and Bolts
- Center Bearing Assemblies
- Grease Zerk (Nipple) Fittings

Note – Spicer Life Series 140, 170 and 250 driveshaft assemblies and components are metric. To eliminate any confusion between S.A.E. and metric threaded fasteners, the metric fasteners have been color coded gold. Spicer Life metric fasteners include spring tab bolts, bearing retainer bolts and midship nuts.

INSTALLATION PROCEDURE FOR END FITTINGS

SPICER LIFE SERIES 55, 70, 90, 100, 140, 170 & 250

Refer to the transmission, axle or transfer case original equipment manufacturers' service and maintenance manuals for proper procedures.

For center bearing fittings, refer to pages in this section for proper installation procedures for center bearings.

INSTALLATION PROCEDURE FOR UNIVERSAL JOINT KITS

SPICER LIFE SERIES 55, 70, 90, 100, 140, 170 & 250

Required Tools

- Ratchet or Air Gun
- Six-Point, 8mm Socket (Spicer Life 140, 170 & 250)
- Chisel (Spicer Life 55, 70, 90 & 100)
- Torque Wrench
- Hammer
- Pliers – For Snap Rings (Spicer Life 55, 70, 90 & 100)

One of the following is recommended:

- Three ton minimum, Arbor Press, along with
  (for Spicer Life Series 55, 70, 90, 100, 140, 170 & 250)
  Bearing Cup Spacer
  Push Rod
  Metal Plate 0.25 inches (6.4 mm) thick,

or

- J & J Tool Co., Inc. (see photo 104, right)
  Universal Joint Puller Kit 4LIFE – Basic or Complete
  (for Spicer Life Series 140, 170 & 250)
  1-800-221-4903
  Outside U. S. A. and Canada 1-215-256-9300,

or

- Tiger Tool TGLS-597 (See photo 105, right)
  or Mark 10A (not shown)
  (for Spicer Life Series 140, 170 & 250)
  1-800-661-4660
  Outside U. S.A. and Canada 1-604-855-1133

QUICK DISCONNECT™ SPRING TAB STYLE SPICER LIFE SERIES 140, 170 & 250

Caution – Be sure to carefully read all information on page 115 as well as grease recommendations and compatibility information in the lubrication section of this manual, before proceeding.

Note – Spicer Life replacement universal joint kit bearing assemblies contain only enough grease to provide needle roller bearing protection during storage. It is therefore necessary to completely lubricate each bearing assembly. It is also necessary to fully lubricate the universal joint kit after it is installed in the vehicle.

Photo 104

Photo 105

Photo 106

Photo 107

1. Remove needle retaining plugs from all bearing cup assemblies. Using a high-quality, N.L.G.I.*, E. P. Grade 2 lubricating grease, wipe each bearing cup assembly with grease. Fill all cavities between the needle rollers. Also apply a liberal coating of grease on the bottom of each bearing cup assembly and on the lip of the seal. (See photo 106, above.) ▲ See warning, below.

National Lubricating Grease Institute

▲ ***WARNING***

Inadequate lubrication can cause driveline failure, which can result in separation of the driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.

Caution – Spicer **DOES NOT** recommend wiping the outside of bearing cup assemblies or yoke cross holes with grease, oil or silicone-based sprays. This could result in bearing cup assembly rotation in yokes. ▲ See warning, below.

▲ ***WARNING***

Rotating bearing cup assemblies can result in yoke cross hole wear and distortion. Distorted yokes can result in separation of the driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.

2. Position the journal cross into the yoke cross holes with the grease zerk (nipple) fitting inward toward tubing. The double-headed, grease zerk (nipple) fitting should be perpendicular to the yoke cross holes. (See photo 107, above.)

Failure to properly position the universal joint will result in the inability to grease the universal joint. ▲ See warning, step 1, regarding inadequate lubrication.

If using an arbor press, proceed to step 3. If using a universal joint installation tool, follow the tool manufacturer's instructions, then proceed to page 136 for installation procedures for Quick Disconnect™ driveshaft assemblies.

3. Move one end of the journal cross to cause a trunnion to project through the cross hole beyond the outer machined face of the yoke ear. Take one bearing cup assembly and position an installation height tool on the end of the bearing cup assembly. Place the bearing cup assembly over the protruding trunnion diameter and align it to the yoke cross hole. (See photo 108, below.)

Photo 108

Photo 109

Photo 110

Photo 111

4. Align the yoke in an arbor press with the bearing assembly resting on the base of the press. (See photo 109, left.) Cover the yoke ear with a metal plate that has 0.25 inch (6.4 mm) minimum thickness. Push the yoke onto the bearing cup assembly until the installation height tool is flush with the cross hole face. **Do not remove the installation height tool.**

5. Flip yoke 180 degrees. Position the remaining installation height tool on the end of another bearing cup assembly. Place bearing cup assembly over trunnion diameter and align it to the yoke cross hole. Push the bearing cup assembly until both installation height tools are flush with the cross hole face. (See photo 110, left center.) **Remove and discard both installation height tools.**

6. Install **new** spring tabs and 8mm thread bolts. Make sure that no grease or foreign material is present between the contact areas of the spring tabs, bearing cups and yoke cross hole faces. Tighten bolts to the required torque. (See photo 111, bottom left.) See spring tab bolt torque specification Table JJ below. See warning, below.

SPRING TAB BOLT SPECIFICATIONS

SERIES	THREAD SIZE	HEAD SIZE	BOLT TORQUE Nm	BOLT TORQUE LB. FT.	KIT P/N*
SPL140	8mm x 1.00	8mm, 6 point	35-40	25-30	211941X
SPL170	8mm x 1.00	8mm, 6 point	35-40	25-30	211941X
SPL250	8mm x 1.00	8mm, 6 point	35-40	25-30	211941X

** Bolts are specially heat-treated.*
DO NOT substitute inferior grade bolts.

Table JJ

WARNING

Reuse of spring tabs or spring tab bolts or failure to properly tighten spring tab bolts to required specifications can cause the driveline to loosen and separate from the vehicle. A separated driveline can result in property damage, serious personal injury or death.

7. Proceed to page 136 for installation of the driveshaft into the vehicle.

COMPANION FLANGE/FLANGE YOKE (S.A.E., DIN AND T-TYPE) SPRING TAB STYLE SPICER LIFE SERIES 140, 170 & 250

Caution – Be sure to carefully read all information on page 115 as well as grease recommendations and compatibility information in the lubrication section of this manual, before proceeding.

Note – Spicer Life replacement universal joint kits contain only enough grease to provide needle roller bearing protection during storage. It is therefore necessary to completely lubricate each universal joint kit after it is installed in the vehicle.

1. Remove needle retaining plugs from all bearing cup assemblies. Using a high-quality, N.L.G.I.*, E. P. Grade 2 lubricating grease, wipe each bearing cup assembly with grease. Fill all the cavities between the needle rollers. Also apply a liberal coating of grease on the bottom of each bearing cup assembly and on the lip of the seal. (See photo 112, below.) ▲ See warning, below.

**National Lubricating Grease Institute.*

▲ ***WARNING***

Inadequate lubrication can cause driveline failure, which can result in separation of the driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.

Photo 112

Caution – Spicer **DOES NOT** recommend wiping the outside of bearing cup assemblies or yoke cross holes with grease, oil or silicone based sprays. This could result in bearing cup assembly rotation in yokes. ▲ See warning, below.

▲ ***WARNING***

Rotating bearing cup assemblies can result in yoke cross hole wear and distortion. Distorted yokes can result in separation of the driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.

Photo 113

Photo 114

2. Position the journal cross into the yoke cross holes with grease zerk (nipple) fitting inward toward tubing. The double-headed, grease zerk (nipple) fitting should be perpendicular to yoke cross holes. (See photo 113, above.)

Failure to properly position the universal joint will result in the inability to grease the universal joint. ▲ See warning, below.

▲ ***WARNING***

Inadequate lubrication can cause driveline failure, which can result in separation of the driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.

If using an arbor press proceed to step 3. If using a universal joint installation tool, follow the tool manufacturer's instructions, then proceed to page 147 for installation procedures for companion flange/flange yoke driveshaft assemblies.

3. Move one end of the journal cross to cause a trunnion to project through the cross hole beyond the outer machined face of the yoke ear. Take one bearing cup assembly and position an installation height tool on the end of a bearing cup. Place the bearing cup assembly over the protruding trunnion diameter and align it to yoke cross hole. (See photo 114, top right.)

4. Align the yoke in an arbor press with the bearing cup assembly resting on the base of the press. (See photo 115, below.) Cover the yoke ear with a metal plate 0.25 inch (6.4 mm) minimum thickness. Push the yoke onto the bearing cup assembly until the installation height tool is flush with the cross hole face. **Do not remove installation height tool**.

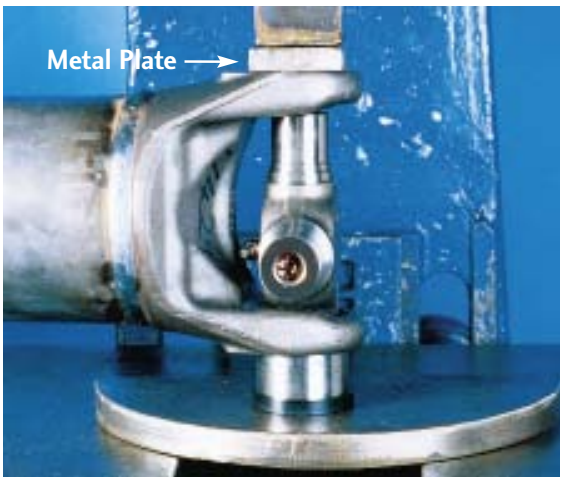


Photo 115

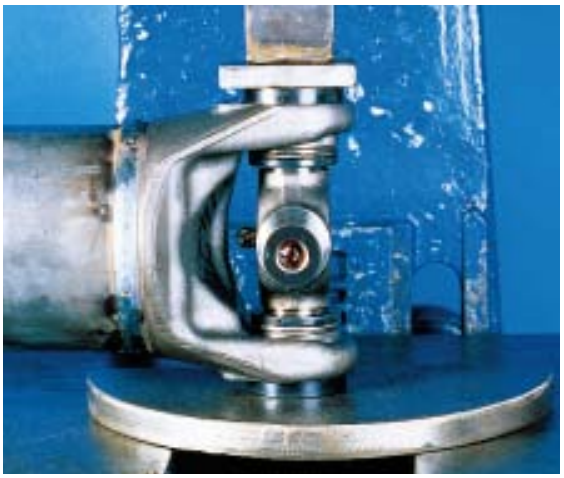


Photo 116

5. Flip yoke 180 degrees. Position remaining installation height tool on end of another bearing cup assembly. Place bearing cup assembly over trunnion diameter and align it to the yoke cross hole. Push the bearing cup assembly until both installation height tools are flush with cross hole face. (See photo 116, above.) **Remove both installation height tools**.

6. Position flange yoke cross holes over remaining trunnions.

7. Take one bearing cup assembly and position an installation height tool on the end of a bearing cup. Place the bearing cup assembly over one of the trunnion diameters and align it to flange yoke cross hole.

8. Align yoke in arbor press with the bearing cup assembly resting on the base of arbor press. Cover the yoke ear with a metal plate 0.25 inch (6.4mm) minimum thickness. Push the yoke onto the bearing cup assembly until the installation height tool is flush with cross hole face. **Do not remove installation height tool.**

9. Flip yoke 180 degrees. Position remaining installation height tool on last bearing cup assembly. Place bearing cup assembly over remaining trunnion diameter and align it to the flange yoke cross hole. Push the bearing cup assembly until both installation height tools are flush with cross hole face. **Remove and discard both installation height tools.**

10. Install **new** spring tabs and 8mm thread bolts, and torque to required specifications. Make sure that no grease or foreign material is present between the contact areas of the spring tabs, bearing cups and yoke cross hole faces. Tighten bolts to the required torque. See spring tab bolt specifications Table KK, below. ⏢ See warning, below.

SPRING TAB BOLT SPECIFICATIONS

SERIES	THREAD SIZE	HEAD SIZE	BOLT TORQUE Nm	BOLT TORQUE LB. FT.	KIT P/N*
SPL140	8mm x 1.00	8mm, 6 point	35-40	25-30	211941X
SPL170	8mm x 1.00	8mm, 6 point	35-40	25-30	211941X
SPL250	8mm x 1.00	8mm, 6 point	35-40	25-30	211941X

** Bolts are specially heat-treated.*
DO NOT substitute inferior grade bolts.

Table KK

⏢ ***WARNING***

Reuse of spring tab bolts or failure to properly tighten spring tab bolts to required specifications can cause the driveline to loosen and separate from the vehicle. A separated driveline can result in property damage, serious personal injury or death.

11. Proceed to page 147 for installation of the driveshaft into the vehicle.

QUICK DISCONNECT™ SNAP RING STYLE SPICER LIFE SERIES 55, 70, 90 & 100

Caution – Be sure to carefully read all information on page 115 as well as grease recommendations and compatibility information in the lubrication section of this manual, before proceeding.

Required Tools

- Chisel
- Hammer
- Pliers – For Snap Rings

One of the following is recommended:

- Arbor Press, along with
  Bearing Cup Spacer
  Push Rod
  Metal Plate 0.25 inch (6.4 mm) thick,

or contact

- J & J Tool Co., Inc.
  Joint Puller
  1-800-221-4903
  Outside U. S. A. and Canada 1-215-256-9300,

or

- Tiger Tool Kit
  1-800-661-4660
  Outside U. S.A. and Canada 1-604-855-1133

Note – Spicer Life replacement universal joint kit bearing assemblies contain only enough grease to provide needle roller bearing protection during storage. It is therefore necessary to completely lubricate each bearing assembly. It is also necessary to fully lubricate the universal joint kit after it is installed in the vehicle.

Photo 117

1. Using a high quality N.L.G.I.*, E. P. Grade 2 lubricating grease, wipe each bearing cup assembly with grease. Fill all cavities between the needle rollers. Also apply a liberal coating of grease on the bottom of each bearing cup assembly and on the lip of the seal. (See photo 117, above.) See warning, below.

**National Lubricating Grease Institute*

WARNING

Inadequate lubrication can cause driveline failure, which can result in separation of the driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.

Caution – Spicer **DOES NOT** recommend wiping the outside of bearing cup assemblies or yoke cross holes with grease, oil or silicone-based sprays. This could result in bearing cup assembly rotation in yokes. See warning, below.

WARNING

Rotating bearing cup assemblies can result in yoke cross hole wear and distortion. Distorted yokes can result in separation of the driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.

Photo 118

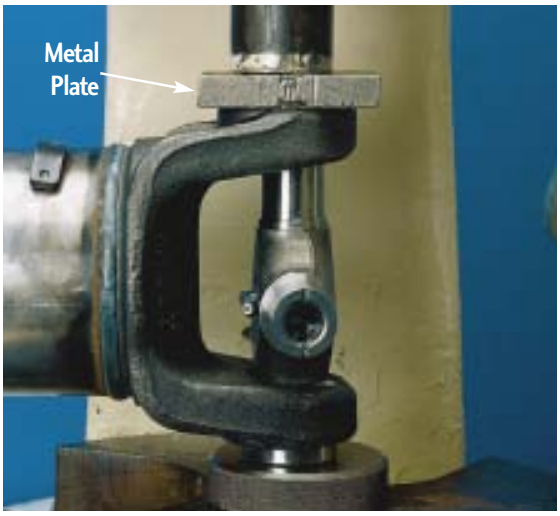


Photo 119

2. Position the journal cross into the yoke cross holes with grease zerk (nipple) fitting inward toward tubing. The double-headed, grease zerk (nipple) fitting should be perpendicular to the yoke cross holes. (See photo 118, above.)

Failure to properly position the universal joint kit will result in the inability to grease the universal joint. ▲ See warning, below.

▲ ***WARNING***

Inadequate lubrication can cause driveline failure, which can result in separation of the driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.

If using an arbor press, proceed to step 3. If using a universal joint installation tool, follow the tool manufacturer's instructions. Then proceed to page 136 for installation procedures for Quick Disconnect™ driveshaft assemblies.

3. Move one end of the journal cross to cause a trunnion to project through the cross hole beyond the outer machined face of the yoke ear. Place the bearing cup assembly over the protruding trunnion diameter and align it to the yoke cross hole.

Align the yoke in an arbor press with the bearing assembly resting on the base of the press (see photo 119, above.) Cover the yoke ear with a metal plate that has 0.25 inch (6.4 mm) minimum thickness. Push the yoke onto the bearing cup assembly until it is flush with the cross hole face.

4. Place a push rod that is smaller than the diameter of the bearing cup assembly under the bearing cup assembly and continue pressing into the yoke cross hole until far enough to install a snap ring. (See photo 120, below.)

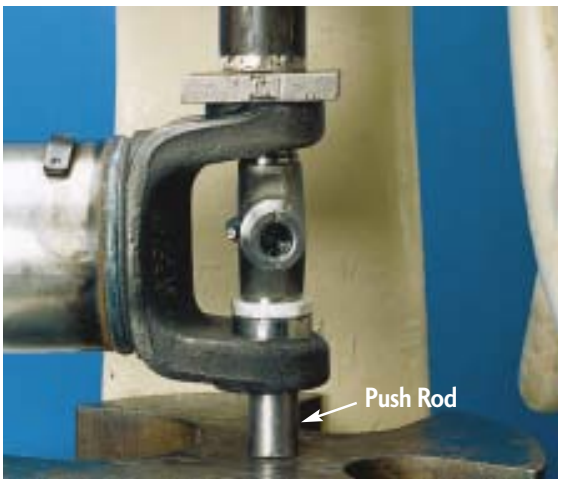


Photo 120

5. Remove yoke from arbor press. Install a snap ring using snap ring pliers.

6. Flip yoke 180 degrees. Place another bearing cup assembly over trunnion diameter and align it to yoke cross hole. Align yoke in arbor press with previously installed bearing cup assembly resting on base of press. Place a push rod that is smaller than the bearing cup assembly on top of the bearing cup assembly. Press bearing cup assembly into the yoke cross hole until far enough to install a snap ring. (See photo 121, below.)

Photo 121

7. Remove yoke from arbor press. Install a snap ring using snap ring pliers.

8. Seat installed snap rings into grooves using a small chisel or punch. (See photo 122, below.)

Photo 122

9. Flex the journal cross to make sure it moves smoothly and freely in the bearings.

If the joint is stiff, place a plate on the yoke ear and hit the plate with a hammer to seat the bearing cup assemblies. (See photo 123, below.) ▲ See warning, below.

Photo 123

▲ ***WARNING***

TO PREVENT *eye injury, always wear safety glasses when performing maintenance or service. Failure to wear safety glasses could result in serious personal injury and/or partial or complete vision loss.*

10. Flex the journal cross to make sure it moves smoothly and freely in the bearings. If not, disassemble and inspect the journal and bearing assemblies for skewed or dropped needle rollers. Reference removal procedures for universal joints, snap ring style, page 82.

11. Proceed to page 136 for installation of the driveshaft into the vehicle.

COMPANION FLANGE/FLANGE YOKE (S.A.E., DIN AND T-TYPE) SNAP RING STYLE SPICER LIFE SERIES 55, 70, 90 & 100

Caution – Be sure to carefully read all information on page 115 as well as grease recommendations and compatibility information in the lubrication section of this manual, before proceeding.

Note – Spicer Life replacement universal joint kit bearing assemblies contain only enough grease to provide needle roller bearing protection during storage. It is therefore necessary to completely lubricate each bearing assembly. It is also necessary to fully lubricate the universal joint kit after it is installed in the vehicle.

1. Using a high quality N.L.G.I.* Grade 2 lubricating grease, wipe each bearing cup assembly with grease. Fill all cavities between the needle rollers. Also apply a liberal coating of grease on the bottom of each bearing cup assembly and on the lip of the seal. (See photo 124, below.) ▲ See warning, below.

**National Lubricating Grease Institute*

▲ ***WARNING***

Inadequate lubrication can cause driveline failure, which can result in separation of the driveline from the vehicle. A separated driveline could result in property damage, serious personal injury or death.

Photo 124

Caution – Spicer **DOES NOT** recommend wiping the outside bearing cup assemblies or yoke cross holes with grease, oil or silicone-based sprays. This could result in bearing cup assembly rotation in yokes. ▲ See warning, below.

▲ ***WARNING***

Rotating bearing cup assemblies can result in yoke cross hole wear and distortion. Distorted yokes can result in separation of the driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.

2. Position the journal cross into the yoke cross holes with grease zerk (nipple) fitting inward toward tubing. The double-headed, grease zerk (nipple) fitting should be perpendicular to the yoke cross holes. (See photo 125, below.)

Failure to properly position the universal joint kit will result in the inability to grease the universal joint. ▲ See warning, step 1, regarding inadequate lubrication.

If using an arbor press, proceed to step 3. If using a universal joint installation tool, follow the tool manufacturer's instructions. Then proceed to page 147 for installation procedures for companion flange/flange yoke driveshaft assemblies.

Photo 125

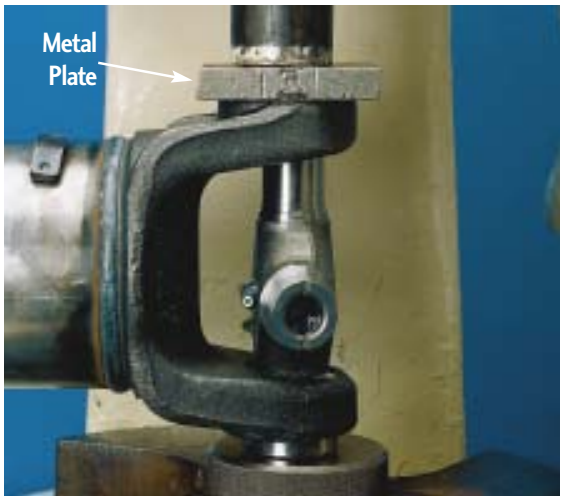


Photo 126

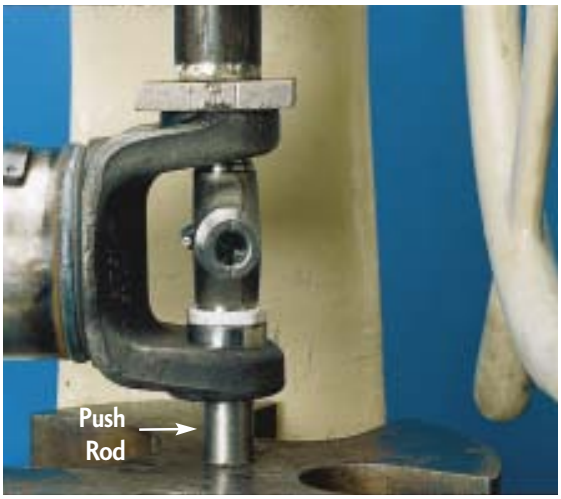


Photo 127

3. Move one end of the journal cross to cause a trunnion to project through the cross hole beyond the outer machined face of the yoke ear. Place the bearing cup assembly over the protruding trunnion diameter and align it to the yoke cross hole.

Align the yoke in an arbor press with the bearing assembly resting on the base of the press. (See photo 126, above.) Cover the yoke ear with a metal plate that has 0.25 inch (6.4 mm) minimum thickness. Push the yoke onto the bearing cup assembly until it is flush with the cross hole face.

4. Place a push rod that is smaller than the diameter of the bearing cup assembly under the bearing cup assembly and continue pressing into the yoke cross hole until far enough to install a snap ring. (See photo 127, top right.)

5. Remove yoke from arbor press. Install a snap ring using snap ring pliers.

6. Flip yoke 180 degrees. Place another bearing cup assembly over trunnion diameter and align it to yoke cross hole. Align yoke in arbor press with previously installed bearing cup assembly resting on base of press. Place a push rod that is smaller than the bearing cup assembly on top of the bearing cup assembly. Press bearing cup assembly into the yoke cross hole until far enough to install a snap ring. (See photo 128, below.)

7. Remove yoke from arbor press. Install a snap ring using snap ring pliers.

Photo 128

Photo 129

8. Seat the snap rings into grooves using a small chisel or punch. (See photo 129, above.)

9. Position flange yoke cross holes over remaining trunnions.

10. Place a bearing cup assembly over a protruding trunnion diameter and align it to the flange yoke cross hole.

11. Align the yoke in an arbor press with the bearing assembly resting on the base of the press. Cover the yoke ear with a metal plate that has 0.25 inch (6.4 mm) minimum thickness. Push the yoke onto the bearing cup assembly until it is flush with the cross hole face.

12. Place a push rod that is smaller than the diameter of the bearing cup assembly under the bearing cup assembly and continue pressing into the flange yoke cross hole until far enough to install a snap ring.

13. Remove yoke from arbor press. Install a snap ring using snap ring pliers.

14. Flip yoke 180 degrees. Place remaining bearing cup assembly over trunnion diameter and align it to flange yoke cross hole. Align yoke in arbor press with previously installed bearing cup assembly resting on base of press. Place a push rod that is smaller than the bearing cup assembly on top of the bearing cup assembly. Press bearing cup assembly into the yoke cross hole until far enough to install a snap ring.

15. Remove yoke from arbor press. Install a snap ring using snap ring pliers.

16. Seat the snap rings into grooves using a small chisel or punch.

17. Flex the journal cross to make sure it moves freely in bearings. If the joint is stiff, place a plate on the yoke ear and hit the plate with a hammer to seat the bearing cup assemblies. ▲ See warning, below.

▲ ***WARNING***

TO PREVENT *eye injury, always wear safety glasses when performing maintenance or service. Failure to wear safety glasses could result in serious personal injury and/or partial or complete vision loss.*

18. Flex the journal cross to make sure it moves smoothly and freely in bearings. If not, disassemble and inspect the journal and bearing assemblies for skewed or dropped needle rollers. Reference removal procedures for universal joints, snap ring style, page 82.

19. Proceed to page 147 for installation of the driveshaft into the vehicle.

INSTALLATION PROCEDURE FOR CENTER BEARINGS

SPICER LIFE SERIES 55, 70, 90, 100, 140, 170 & 250

Required Tools

- Six-Point Socket
  English 1 5/8," or
  Metric 41mm
- Soft-Faced Hammer
- Section of Tubing
- Air Gun or Ratchet

QUICK DISCONNECT™ YOKE STYLE SPICER LIFE SERIES 55, 70, 90, 100, 140, 170 & 250

1. Wipe the bearing surface of the midship tube shaft with a fine emery cloth.

2. Install a new slinger (included in center bearing replacement kit) on the midship tube shaft using a section of tubing to avoid damaging slinger. Make sure the slinger is completely seated against the midship tube shaft shoulder. (See photo 130, below.)

Photo 130

Photo 131

3. Before installing the new center bearing assembly, be sure to fill the entire cavity around the bearing with waterproof lubricant. (See photo 131, above.) Enough lubricant must be applied to fill the cavity to the extreme edge of the slinger surrounding the bearing. Lubricants **must** be waterproof. See Table LL, below for recommended lubricants. See warning, below.

WARNING

Inadequate lubrication can cause driveline failure, which can result in separation of the driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.

RECOMMENDED CENTER BEARING LUBRICANTS

LUBRICANTS	SOURCE
Rykon Premium No. 3	Amoco Oil Company
Amolith 8516	Amoco Oil Company
Van Talgar No. 4	Exxon Company

Table LL

Photo 132

Photo 133

4. Carefully align the new center bearing assembly with the ground surface of the midship tube shaft. Physically push the center bearing onto the midship tube shaft. (See photo 132, above.)

5. Press remaining slinger on end yoke using a section of tubing to avoid damaging slinger. (See photo 133, top right.)

6. Using a soft-faced hammer, tap the yoke onto midship tube shaft, **making sure phasing marks from driveshaft removal procedure are in line**. Continue to tap the yoke until it is completely seated against the center bearing.

7. Install a washer (if required) and **new** midship nut and torque nut to specifications. See midship nut specifications, Table MM, top right. ▲ See warning, below.

▲ ***WARNING***

Failure to torque midship nut to required specifications can cause driveline failure, which can result in separation of the driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.

MIDSHIP NUT SPECIFICATIONS

SERIES	NUT P/N	WASHER P/N	HEAD SIZE*	NUT TORQUE Nm	NUT TORQUE LB. FT.
SPL55	TBD	TBD	TBD	TBD	TBD
SPL70	TBD	TBD	TBD	TBD	TBD
SPL90	231502	N/A	1 5/8"	644-712	475-525
SPL100	TBD	TBD	TBD	TBD	TBD
SPL140	250-74-11	230123-6	41mm*	644-712	475-525
SPL170	250-74-11	230123-6	41mm*	644-712	475-525
SPL250	250-74-11	230123-6	41mm*	644-712	475-525

** A 1 5/8" socket may be used.*

Table MM

8. Proceed to page 136 for installation of the driveshaft into the vehicle.

COMPANION FLANGE/FLANGE YOKE STYLE
(S.A.E., DIN AND T-TYPE)
SPICER LIFE SERIES 55, 70, 90, 100, 140, 170 & 250

1. Wipe the bearing surface of the midship tube shaft with a fine emery cloth.

2. Install a new slinger (included in center bearing replacement kit) on the midship tube shaft using a section of tubing to avoid damaging slinger. Make sure the slinger is completely seated against the midship tube shaft shoulder. (See photo 134, below.)

Photo 134

3. Before installing the new center bearing assembly, be sure to fill the entire cavity around the bearing with a waterproof lubricant. (See photo 135, top right.) Enough lubricant must be applied to fill the cavity to the extreme edge of the slinger surrounding the bearing. Lubricants **must** be waterproof. See Table NN, top right, for recommended lubricants. ▲ See warning, below.

▲ ***WARNING***

Inadequate lubrication can cause driveline failure, which can result in separation of the driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.

Photo 135

RECOMMENDED CENTER BEARING LUBRICANTS

LUBRICANTS	SOURCE
Rykon Premium No. 3	Amoco Oil Company
Amolith 8516	Amoco Oil Company
Van Talgar No. 4	Exxon Company

Table NN

4. Carefully align the center bearing assembly with the ground surface of the midship tube shaft. Physically push the center bearing onto the midship tube shaft. (See photo 136, below.)

Photo 136

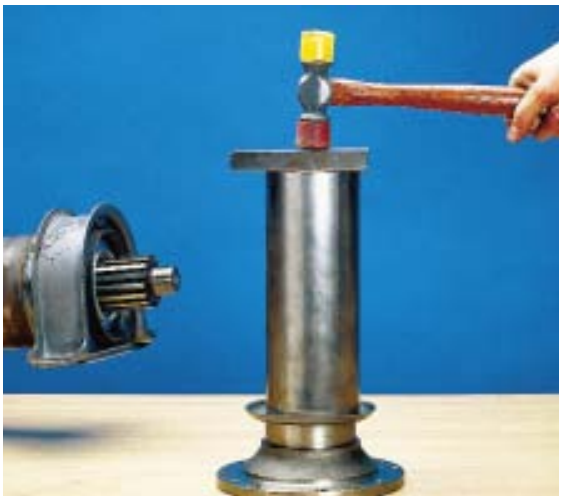


Photo 137

5. Press remaining slinger onto the companion flange using a section of tubing to avoid damaging slinger. (See photo 137, above.)

6. Using a soft-faced hammer, tap the companion flange onto the midship tube shaft, **making sure phasing marks from removal procedure are in line**. Continue to tap the companion flange until it is completely seated against the center bearing.

MIDSHIP NUT SPECIFICATIONS

SERIES	NUT P/N	WASHER P/N	HEAD SIZE	NUT TORQUE Nm	NUT TORQUE LB. FT.
SPL55	TBD	TBD	TBD	TBD	TBD
SPL70	TBD	TBD	TBD	TBD	TBD
SPL90	231502	N/A	15/8"	644-712	475-525
SPL100	TBD	TBD	TBD	TBD	TBD
SPL140	250-74-11	230123-6	41mm*	644-712	475-525
SPL170	250-74-11	230123-6	41mm*	644-712	475-525
SPL250	250-74-11	230123-6	41mm*	644-712	475-525

** A 1 5/8" socket may be used.*

Table PP

7. Install washer (if required) and **new** midship nut and torque nut to specifications. See midship nut specifications, Table PP, above. ▲ See warning, below.

▲ ***WARNING***

Failure to torque midship nut to required specifications can cause driveline failure, which can result in separation of the driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.

8. Proceed to page 147 for installation of the driveshaft into the vehicle.

OUTBOARD SLIP STYLE
SPICER LIFE SERIES 55, 70, 90 & 100

1. Wipe the bearing surface of the midship tube shaft with a fine emery cloth.

2. Install a new slinger (included in center bearing replacement kit) on the midship tube shaft using a section of tubing to avoid damaging slinger. Make sure the slinger is completely seated against the midship tube shaft shoulder. (See photo 138, top right.)

3. When replacing a center bearing assembly, be sure to fill the entire cavity around the bearing with a waterproof lubricant (see photo 139, center right.) Enough lubricant must be applied to fill the cavity to the extreme edge of the slinger surrounding the bearing. Lubricants **must** be waterproof. See Table QQ, bottom right for recommended lubricant.

See warning, below.

WARNING

Inadequate lubrication can cause driveline failure, which can result in separation of the driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.

4. Carefully align the center bearing assembly with the ground surface of midship tube shaft. Physically push the center bearing onto the midship tube shaft.

5. Proceed to page 136 for installation of the driveshaft into the vehicle.

Photo 138

Photo 139

RECOMMENDED CENTER BEARING LUBRICANTS

LUBRICANTS	SOURCE
Rykon Premium No. 3	Amoco Oil Company
Amolith 8516	Amoco Oil Company
Van Talgar No. 4	Exxon Company

Table QQ

INSTALLATION PROCEDURE FOR SLIP MEMBER BOOT

SPICER LIFE SERIES 55, 70, 100, 140, 170 & 250

Required Tools

- Boot Clamp Pliers
  Lisle Corporation Part Number: 30800, or
  Snap-On Part Number: YA3080
- Tape Measure or Ruler
- Soft-Faced Hammer (brass, plastic or rubber)
- Grease-Cutting Solvent

1. Clean **ALL** grease from yoke shaft and spline sleeve. Make sure grease-cutting solvent does not intrude into the tube through the vent hole in the spline sleeve plug. **Be sure the phasing marks made during disassembly are not removed.** (See photo 140, top right.)

2. After all traces of grease-cutting solvent have been removed from yoke shaft and spline sleeve, apply enough N.L.G.I*, E. P. Grade 2 grease (provided in slip member boot replacement kit) to fill the entire length of all teeth in the spline sleeve (see photo 141, right.) Wipe any excess grease on the **teeth** of the yoke shaft. ▲ See warning, below.
**National Lubricating Grease Institute*

▲ ***WARNING***

Inadequate lubrication can cause driveline failure, which can result in separation of the driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.

Photo 140

Photo 141

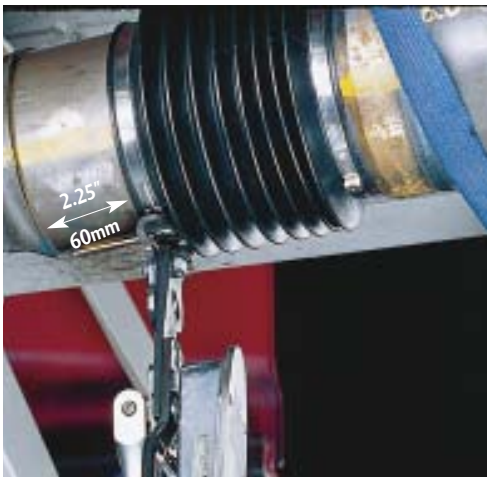


Photo 142

3. Measure and place a mark 2.25 inches (55-60mm) from yoke shaft shoulder with a marking stick, paint marker or other legible marking device. (See photo 142, above.)

4. Position a clamp on each end of the new boot. Slide the boot onto the **grease-free** yoke shaft shoulder.

5. Collapse the boot and insert the yoke shaft into the splined sleeve, **making sure phasing marks are in line.** Position the end of the boot at the 2.25 inches (55-60mm) mark made on the yoke shaft shoulder and tighten boot clamps to the specified torque. (See photo 142, above.) **Yoke shaft shoulder must be clean, dry and grease-free.** See boot clamp torque specification, Table RR, top right. See warning, below.

WARNING

Failure to properly install and tighten boot clamps could allow intrusion of contaminants and can cause driveline failure, which can result in separation of the driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.

BOOT CLAMP SPECIFICATIONS

SERIES	CLAMP P/N	CLAMP TORQUE Nm	CLAMP TORQUE LB. FT.
SPL55	TBD	TBD	TBD
SPL70	TBD	TBD	TBD
SPL100	TBD	TBD	TBD
SPL140	232757	136-180	100-130
SPL170	232493	136-180	100-130
SPL170*	232702	136-180	100-130
SPL250	232493	136-180	100-130

**high angle interaxle position only*

Table RR

6. Before the driveshaft is completely installed in the vehicle, slowly collapse and extend the driveshaft to make sure the boot clamps are stationary. If the clamps are not stationary, recheck for proper clamp torque. If clamps still are not stationary, repeat disassembly and assembly procedure. **DO NOT reuse clamps**. See warning, below.

WARNING

Reuse of boot clamps or failure to properly tighten boot clamps to required specifications could allow intrusion of contaminants onto slip member and can cause driveline failure, which can result in separation of the driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.

Quick Disconnect™ Style

Proceed to step 7.

Companion Flange/Flange Yoke (S.A.E., DIN and T-Type Style)

Proceed to step 9.

Quick Disconnect™ Style

7. If clamps are stationary, use a soft-faced hammer to tap universal joint into the end yoke. Make sure to align universal joint in end yoke, **matching up phasing marks made during removal to ensure original driveshaft orientation.**

QUICK DISCONNECT BOLT SPECIFICATIONS

SERIES	BOLT P/N*	THREAD SIZE	HEAD SIZE	BOLT TORQUE Nm	BOLT TORQUE LB. FT.
SPL55	TBD	TBD	TBD	TBD	TBD
SPL70	TBD	TBD	TBD	TBD	TBD
SPL90	6-73-412	0.375 in. - 24	3/8 in. 12 point	61-81	45-60
SPL100	TBD	TBD	TBD	TBD	TBD
SPL140	12-73-125M	12mm - 1.25	12 mm 12 point	135-160	100-120
SPL170	12-73-125M	12mm - 1.25	12 mm 12 point	135-160	100-120
SPL250	12-73-125M	12mm - 1.25	12 mm 12 point	135-160	100-120

** Bolts are specially heat-treated.*
DO NOT substitute inferior grade bolts.

Table SS

8. Install the bearing retainers or **new** stamped straps and **new** bolts. Torque the bolts down evenly and to required specifications. Reference bolt specifications, Table SS, left. ▲ See warning, below. Check to make sure bearing cup assemblies are fully seated in the yoke ears.

▲ ***WARNING***

Failure to torque bolts to specification can cause driveline failure, which can result in separation of the driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.

Companion Flange/Flange Yoke (S.A.E., DIN and T-Type Style)

9. Position the flange yoke face onto the companion flange, **aligning bolt holes and phasing marks.** Make sure flange yoke and companion flange are free from grease or other foreign material and are properly seated.

10. Install **new** bolts, washers (if required) and nuts. Reference hardware specifications, Table TT, below. Bolts must be torqued to required specifications. ▲ See warning, step 8.

COMPANION FLANGE/FLANGE YOKE STYLE (S.A.E., DIN AND T-TYPE) HARDWARE SPECIFICATIONS

SERIES	BOLT P/N*†	WASHER P/N	NUT P/N	DIAMETER, THREAD & LENGTH UNDER HEAD	BOLT TORQUE Nm	BOLT TORQUE FT. LBS.
SPL55	TBD	TBD	TBD	TBD	TBD	TBD
SPL70	TBD	TBD	TBD	TBD	TBD	TBD
SPL90	6-73-1219	500357-11	231421-3	.375" 24 x 1.188"	54-65	40-48
SPL100	TBD	TBD	TBD	TBD	TBD	TBD
SPL140	6-73-220	500357-11	231421-3	.375" 24 x 1.250"	54-65	40-48
	6-73-1227	500357-11	231421-3	.375" 24 x 1.688"	54-65	40-48
SPL170	7-73-122	500357-12	231421-4	.438" 20 x 1.375"	85-102	63-75
	7-73-228	500357-12	231421-4	.438" 20 x 1.750"	85-102	63-75
SPL250	7-73-122	500357-12	231421-4	.438" 20 x 1.375"	85-102	63-75
	7-73-228	500357-12	231421-4	.438" 20 x 1.750"	85-102	63-75

**Bolts are specially heat-treated. DO NOT substitute inferior grade bolts.*
† Approved Spicer hardware.
***Note**-Original equipment vehicle manufacturers' manuals may have alternate specified bolts or metric hardware. Refer to the original equipment service manual for bolt part numbers.*

Table TT

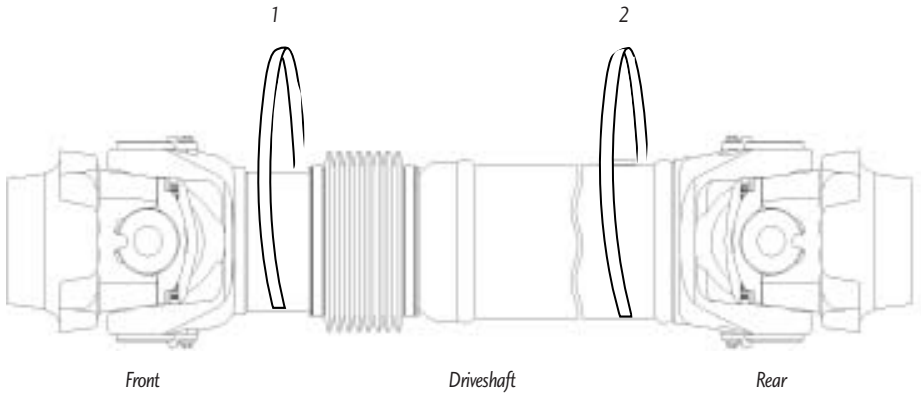


Figure Z,

INSTALLATION PROCEDURE FOR DRIVESHAFT ASSEMBLIES

SPICER LIFE SERIES 55, 70, 90, 100, 140, 170 & 250

Required Tools

- Support Straps
- Ratchet or Air Gun
- Appropriate 12-Point Socket
- Soft-Faced Hammer (Brass, Plastic or Rubber)

QUICK DISCONNECT™ YOKE STYLE

One-Piece Driveshafts

Position Support Straps

1. Position support straps as illustrated in Figure Z, above, to make sure that the driveshaft will be properly supported. ▲ See warning, below.

▲ ***WARNING***

ALWAYS *use support straps to prevent driveshaft from falling out of vehicle. Failure to use support straps can cause damage to driveshaft or result in property damage, serious personal injury or death.*

Attach support straps to frame rails or some structural part of the vehicle. **DO NOT** attach the support straps to fuel lines, oil lines, brake lines, or wiring. **DO NOT** entangle fuel lines, oil lines, brake lines, or wiring in the support straps. ▲ See warning, below.

▲ ***WARNING***

Attaching or entangling support straps to fuel, oil or brake lines or wiring can result in their damage. Damaged fuel, oil or brake lines or wiring can result in failure of the vehicle, which can result in property damage, serious personal injury or death.

Install Driveshaft

2. Place the driveshaft in the support straps. Be sure the driveshaft is placed back in its original orientation. ▲ See warning, below.

▲ ***WARNING***

Installation of a driveline out of original phase can cause vibration and failure of the driveline and attaching components. Failure of a driveline can result in separation of driveline from vehicle. A separated driveline can result in property damage, serious personal injury or death.

3. Working from the **front end**, use a soft-faced hammer to tap the universal joint into the end yoke. Make sure to align

Photo 143

Photo 144

the universal joint in end yoke, **matching up the phasing marks made during removal to ensure original driveshaft orientation**. (See photo 143, above.)

4. Install the bearing retainers or **new** stamped straps and **new bolts** (see photo 144, top right.) Torque the bolts down evenly and to required specifications. Check to make sure the bearing cup assemblies are fully seated in the yoke ears. ▲ See warning, below.

▲ ***WARNING***

Improperly seated bearing cup assemblies can cause driveline failure, which can result in separation of the driveline from the vehicle. A separated driveline could result in property damage, serious personal injury or death.

Reference bolt specifications, Table UU, bottom right. Bolts must be torqued to required specifications. ▲ See warning, below.

▲ ***WARNING***

Failure to install new stamped straps and new bolts and to torque bolts to specifications can cause driveline failure, which can result in separation of the driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.

5. **Be sure the second support strap is in place, as illustrated in Figure Z, page 136.** It may be necessary to collapse the slip member assembly to allow clearance to install driveshaft into the rear end yoke.

Use a soft-faced hammer to tap universal joint into the rear end yoke. Make sure the bearing cup assemblies are fully and properly seated. ▲ See warning, step 4, regarding improperly seated bearing cup assemblies.

6. Repeat step 4.

7. Remove **all** support straps..

8. Completely relubricate all the universal joints and the slip member assembly (if slip member assembly is relubable) as described in the lubrication section of this manual.

QUICK DISCONNECT BOLT SPECIFICATIONS

SERIES	BOLT P/N*	THREAD SIZE	HEAD SIZE	BOLT TORQUE Nm	BOLT TORQUE LB. FT.
SPL55	TBD	TBD	TBD	TBD	TBD
SPL70	TBD	TBD	TBD	TBD	TBD
SPL90	6-73-412	0.375 in. - 24	3/8 in. 12 point	61-81	45-60
SPL100	TBD	TBD	TBD	TBD	TBD
SPL140	12-73-125M	12mm - 1.25	12 mm 12 point	135-160	100-120
SPL170	12-73-125M	12mm - 1.25	12 mm 12 point	135-160	100-120
SPL250	12-73-125M	12mm - 1.25	12 mm 12 point	135-160	100-120

** Bolts are specially heat-treated.*
DO NOT substitute inferior grade bolts.

Table UU

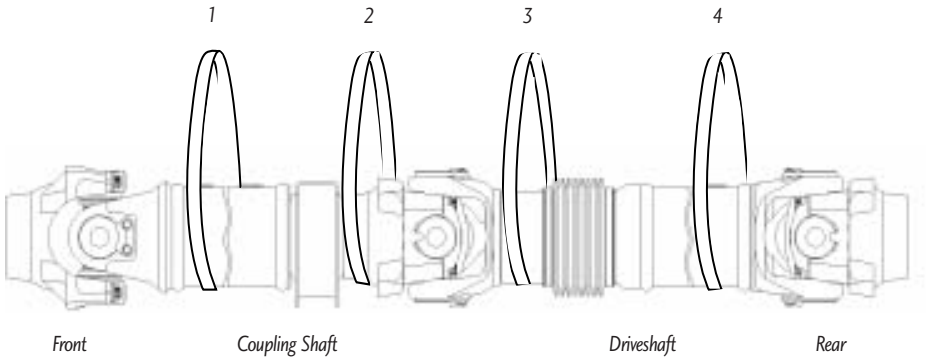


Figure AA

QUICK DISCONNECT™ YOKE STYLE

Two-Piece Driveshafts

Position Support Straps

1. Position support straps as illustrated in Figure AA, above, to make sure that the driveshaft will be properly supported at the slip member, behind the center bearing end fitting and in front of center bearing, with support straps. ▲ See warning, below.

▲ ***WARNING***

ALWAYS *use support straps to prevent driveshaft from falling out of vehicle. Failure to use support straps can cause damage to driveshaft or result in property damage, serious personal injury or death.*

Attach support straps to frame rails or some structural part of the vehicle. **DO NOT** attach the support straps to fuel lines, oil lines, brake lines, or wiring. **DO NOT** entangle fuel lines, oil lines, brake lines, or wiring in the support straps. ▲ See warning, below.

▲ ***WARNING***

Attaching or entangling support straps to fuel, oil or brake lines or wiring can result in their damage. Damaged fuel, oil or brake lines or wiring can result in failure of the vehicle, which can result in property damage, serious personal injury or death.

Install Coupling Shaft

2. Place the coupling shaft in first and second support straps. **Be sure the coupling shaft is placed back in its original orientation.** ▲ See warning, below.

▲ ***WARNING***

Installation of a driveline out of original phase can cause vibration and failure of the driveline and attaching components. Failure of a driveline can result in separation of driveline from vehicle. A separated driveline can result in property damage, serious personal injury or death.

3. Working from the **front** end, use a soft-faced hammer to tap the universal joint into the front end yoke. Make sure to align the universal joint in the front end yoke, **matching up phasing marks made during removal to ensure the driveshaft is reinstalled in its original orientation.**

4. Install the bearing retainers or **new** stamped straps and **new** bolts. Torque the bolts down evenly and to required specifications. Check to make sure the bearing cup assemblies are fully seated in yoke ears. See warning, below.

WARNING

Improperly seated bearing cup assemblies can cause driveline failure, which can result in separation of the driveline from the vehicle. A separated driveline could result in property damage, serious personal injury or death.

Reference bolt specifications, Table VV, below. Bolts must be torqued to required specifications. See warning, below.

WARNING

Failure to install new stamped straps and new bolts and to torque bolts to specification can cause driveline failure, which can result in separation of the driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.

QUICK DISCONNECT BOLT SPECIFICATIONS

SERIES	BOLT P/N*	THREAD SIZE	HEAD SIZE	BOLT TORQUE Nm	BOLT TORQUE LB. FT.
SPL55	TBD	TBD	TBD	TBD	TBD
SPL70	TBD	TBD	TBD	TBD	TBD
SPL90	6-73-412	0.375 in. - 24	3/8 in. 12 point	61-81	45-60
SPL100	TBD	TBD	TBD	TBD	TBD
SPL140	12-73-125M	12mm - 1.25	12 mm 12 point	135-160	100-120
SPL170	12-73-125M	12mm - 1.25	12 mm 12 point	135-160	100-120
SPL250	12-73-125M	12mm - 1.25	12 mm 12 point	135-160	100-120

** Bolts are specially, heat-treated.*
DO NOT substitute inferior grade bolts.

Table VV

Photo 145

5. **Be sure the second support strap is in place, as illustrated in Figure AA, page 138.** Lift the center bearing to the center bearing bracket on the cross member of the frame. Install proper center bearing bracket bolts, per vehicle manufacturer's recommendations. (See photo 145, above.) Torque bolts to vehicle manufacturer's required specifications. See warning, below.

WARNING

Failure to torque bolts to specification can cause driveline failure, which can result in separation of the driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.

Install Driveshaft

6. **Be sure the third and fourth support strap are in place, as illustrated in Figure AA, page 138.** Place the driveshaft in support straps. **Be sure the driveshaft is placed back in its original orientation.**

Center Position Yoke Style

Proceed to step 7, page 140.

Outboard Slip Style

Proceed to step 13, page 141.

Photo 146

Photo 147

Center Position Yoke Style

7. Working from the **rear end**, use a soft-faced hammer to tap the universal joint into the rear end yoke. Make sure to align the universal joint in the rear end yoke, **matching up phasing marks made during removal to ensure original driveshaft orientation**. (See photo 146, above.) See warning, below.

WARNING

Installation of a driveline out of original phase can cause vibration and failure of the driveline and attaching components. Failure of a driveline can result in separation of driveline from vehicle. A separated driveline can result in property damage, serious personal injury or death.

8. Install bearing retainers or **new** stamped straps and **new** bolts. (See photo 147, above.) Torque the bolts down evenly and to required specifications. Check to make sure the bearing cup assemblies are fully seated in yoke ears. Table WW, right. See warning, below.

WARNING

Failure to install new stamped straps, new bolts and torque bolts to specification can cause driveline failure, which can result in separation of the driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.

QUICK DISCONNECT BOLT SPECIFICATIONS

SERIES	BOLT P/N*	THREAD SIZE	HEAD SIZE	BOLT TORQUE Nm	BOLT TORQUE LB. FT.
SPL55	TBD	TBD	TBD	TBD	TBD
SPL70	TBD	TBD	TBD	TBD	TBD
SPL90	6-73-412	0.375 in. - 24	3/8 in. 12 point	61-81	45-60
SPL100	TBD	TBD	TBD	TBD	TBD
SPL140	12-73-125M	12mm - 1.25	12 mm 12 point	135-160	100-120
SPL170	12-73-125M	12mm - 1.25	12 mm 12 point	135-160	100-120
SPL250	12-73-125M	12mm - 1.25	12 mm 12 point	135-160	100-120

** Bolts are specially heat-treated.*
DO NOT substitute inferior grade bolts.

Table WW

9. It may be necessary to collapse slip member assembly to allow clearance to install driveshaft into center bearing end yoke. Use a soft-faced hammer to tap universal joint into center bearing end yoke, matching up phasing marks made during removal to ensure original driveshaft orientation. See warning, step 7.

WARNING

Improperly seated bearing cup assemblies can cause driveline failure which can result in separation of the driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.

10. Install bearing retainers or **new** stamped straps and **new** bolts. Torque the bolts down evenly and to required specifications. Check to make sure the bearing cup assemblies are fully seated in yoke ears. Reference bolt specifications, Table WW, above. ▲ See warning, below.

▲ ***WARNING***

Failure to install new stamped straps and torque bolts to specification can cause driveline failure, which can result in separation of the driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.

11 Completely relubricate all the universal joints and the slip member assemblies (if slip member assembly is relubable) as described in the lubrication section of this manual.

12. Remove **all** support straps.

Outboard Slip Style

13. Guide slip yoke onto midship stub shaft, **making sure phasing marks made during removal are in line**.
▲ See warning, below.

▲ ***WARNING***

Installation of a driveline out of original phase can cause vibration and failure of the driveline and attaching components. Failure of a driveline can result in separation of driveline from vehicle. A separated driveline can result in property damage, serious personal injury or death.

14. Using a soft-faced hammer, tap universal joint into rear end yoke, matching up phasing marks made during removal to ensure original driveshaft orientation. ▲ See warning, step 13.

15. Install the bearing retainers or **new** stamped straps and **new** bolts. Torque the bolts down evenly and to required specifications. Check to make sure the bearing cup assemblies are fully seated in the yoke ears.
(See warning, top right)

QUICK DISCONNECT BOLT SPECIFICATIONS

SERIES	BOLT P/N*	THREAD SIZE	HEAD SIZE	BOLT TORQUE Nm	BOLT TORQUE LB. FT.
SPL55	TBD	TBD	TBD	TBD	TBD
SPL70	TBD	TBD	TBD	TBD	TBD
SPL90	6-73-412	0.375 in. - 24	3/8 in. 12 point	61-81	45-60
SPL100	TBD	TBD	TBD	TBD	TBD
SPL140	12-73-125M	12mm - 1.25	12 mm 12 point	135-160	100-120
SPL170	12-73-125M	12mm - 1.25	12 mm 12 point	135-160	100-120
SPL250	12-73-125M	12mm - 1.25	12 mm 12 point	135-160	100-120

** Bolts are specially heat-treated.*
DO NOT substitute inferior grade bolts.

Table XX

▲ ***WARNING***

Improperly seated bearing cup assemblies can cause driveline failure which can result in separation of the driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.

Reference bolt specifications, Table XX, above. Bolts must be torqued to required specifications. ▲ See warning, below.

▲ ***WARNING***

Failure to install new stamped straps and properly tighten bearing retainer bolts can cause driveline failure, which can result in separation of the driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.

16. Remove **all** support straps.

17. Completely relubricate all the universal joints and the slip member assembly (if slip member assembly is relubable) as described in the lubrication section of this manual.

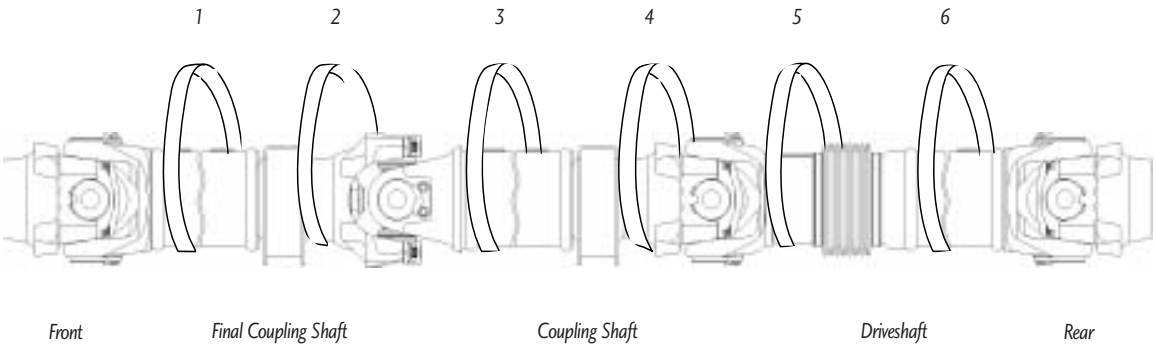


Figure BB

QUICK DISCONNECT™ YOKE STYLE

Multiple-Piece Driveshafts

Position Support Straps

1. Position support straps as illustrated in Figure BB, above, to make sure that the driveshaft will be properly supported at the slip member, behind the center bearing end fittings and in front of center bearing, with support straps. ▲ See warning, below.

▲ ***WARNING***

ALWAYS *use support straps to prevent driveshaft from falling out of vehicle. Failure to use support straps can cause damage to driveshaft or result in property damage, serious personal injury or death.*

Attach support straps to frame rails or some structural part of the vehicle. **DO NOT** attach the support straps to fuel lines, oil lines, brake lines, or wiring. **DO NOT** entangle fuel lines, oil lines, brake lines, or wiring in the support straps. ▲ See warning, below.

▲ ***WARNING***

Attaching or entangling support straps to fuel, oil or brake lines or wiring can result in their damage. Damaged fuel, oil or brake lines or wiring can result in failure of the vehicle, which can result in property damage, serious personal injury or death.

2. When working with multiple-piece driveshafts, start at **front** to install all **coupling shafts**.

Install Final Coupling Shaft

3. Place final **coupling shaft** in support straps. **Be sure the coupling shaft is placed back in its original orientation.** ▲ See warning, below.

▲ ***WARNING***

Installation of a driveline out of original phase can cause vibration and failure of the driveline and attaching components. Failure of a driveline can result in separation of driveline from vehicle. A separated driveline can result in property damage, serious personal injury or death.

4. Working from the **front** end, use a soft-faced hammer to tap the universal joint into the front end yoke. Make sure to align the universal joint in the front end yoke, **matching up phasing marks made during removal to ensure the driveshaft is reinstalled in its original orientation.**

5. Install the bearing retainers or **new** stamped straps and **new** bolts. Torque the bolts down evenly and to required specifications. Check to make sure the bearing cup assemblies are fully seated in yoke ears. ▲ See warning, below.

▲ ***WARNING***

Improperly seated bearing cup assemblies can cause driveline failure, which can result in separation of the driveline from the vehicle. A separated driveline could result in property damage, serious personal injury or death.

QUICK DISCONNECT™ BOLT SPECIFICATIONS

SERIES	BOLT P/N*	THREAD SIZE	HEAD SIZE	BOLT TORQUE Nm	BOLT TORQUE LB. FT.
SPL55	TBD	TBD	TBD	TBD	TBD
SPL70	TBD	TBD	TBD	TBD	TBD
SPL90	6-73-412	0.375 in. - 24	3/8 in. 12 point	61-81	45-60
SPL100	TBD	TBD	TBD	TBD	TBD
SPL140	12-73-125M	12mm - 1.25	12 mm 12 point	135-160	100-120
SPL170	12-73-125M	12mm - 1.25	12 mm 12 point	135-160	100-120
SPL250	12-73-125M	12mm - 1.25	12 mm 12 point	135-160	100-120

** Bolts are specially heat-treated.*
DO NOT substitute inferior grade bolts.

Table YY

Reference bolt specifications, Table YY, above. Bolts must be torqued to required specifications. ▲ See warning, below.

▲ ***WARNING***

Failure to install new stamped straps and new bolts and to torque bolts to specifications can cause driveline failure, which can result in separation of the driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.

6. **Be sure the second support strap is in place, as illustrated in Figure BB, page 142.** Lift the center bearing to the center bearing bracket on the cross member of the frame. Install proper center bearing bracket bolts, per vehicle manufacturer's recommendations. (See photo 148, top right.) Torque bolts to vehicle manufacturer's required specifications. ▲ See warning, below.

▲ ***WARNING***

Failure to torque bolts to specification can cause driveline failure, which can result in separation of the driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.

Install Coupling Shaft(s)

7. **Be sure third and fourth support straps are in place as illustrated in figure BB, page 142.** Place coupling shaft in

Photo 148

support straps. Be sure the coupling shaft is placed back in its original orientation. ▲ See warning, below.

▲ ***WARNING***

Installation of a driveline out of original phase can cause vibration and failure of the driveline and attaching components. Failure of a driveline can result in separation of driveline from vehicle. A separated driveline can result in property damage, serious personal injury or death.

8. Use a soft-faced hammer to tap the universal joint into the center bearing end yoke. Make sure to align the universal joint in the center bearing end yoke, **matching up phasing marks made during removal to ensure the driveshaft is reinstalled in its original orientation.**

9. Install the bearing retainers or **new** stamped straps and **new** bolts. Torque the bolts down evenly and to required specifications. Check to make sure the bearing cup assemblies are fully seated in yoke ears. ▲ See warning, below.

▲ ***WARNING***

Improperly seated bearing cup assemblies can cause driveline failure, which can result in separation of the driveline from the vehicle. A separated driveline could result in property damage, serious personal injury or death.

Reference bolt specifications, Table YY, above. Bolts must be torqued to required specifications. ▲ See warning, step 6.

Photo 149

Photo 150

10. **Be sure the fourth support strap is in place, as illustrated in Figure BB, page 142.** Lift the center bearing to the center bearing bracket on the cross member of the frame. Install proper center bearing bracket bolts, per vehicle manufacturer's recommendations. (See photo 148, page 143.) Torque bolts to vehicle manufacturer's required specifications. ▲ See warning, below.

▲ ***WARNING***

Failure to torque bolts to specification can cause driveline failure, which can result in separation of the driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.

11. Repeat steps 7 through 10 as necessary to install any remaining coupling shafts.

Install Driveshaft

12. **Be sure the fifth and sixth support straps are in place, as illustrated in Figure BB, page 142.** Place the **driveshaft** in support straps. **Be sure the driveshaft is placed back in its original orientation.**

Center Position Yoke Style

Proceed to step 13.

Outboard Slip Style

Proceed to step 19, page 145.

QUICK DISCONNECT™ BOLT SPECIFICATIONS

SERIES	BOLT P/N*	THREAD SIZE	HEAD SIZE	BOLT TORQUE Nm	BOLT TORQUE LB. FT.
SPL55	TBD	TBD	TBD	TBD	TBD
SPL70	TBD	TBD	TBD	TBD	TBD
SPL90	6-73-412	0.375 in. - 24	3/8 in. 12 point	61-81	45-60
SPL100	TBD	TBD	TBD	TBD	TBD
SPL140	12-73-125M	12mm - 1.25	12 mm 12 point	135-160	100-120
SPL170	12-73-125M	12mm - 1.25	12 mm 12 point	135-160	100-120
SPL250	12-73-125M	12mm - 1.25	12 mm 12 point	135-160	100-120

** Bolts are specially heat-treated.*
DO NOT substitute inferior grade bolts.

Table ZZ

Center Position Yoke Style

13. Working from the **rear end**, use a soft-faced hammer to tap the universal joint into the rear end yoke. Make sure to align the universal joint in the rear end yoke, **matching up phasing marks made during removal to ensure original driveshaft orientation**. (See photo 149, above.) ▲ See warning, below.

▲ ***WARNING***

Installation of a driveline out of original phase can cause vibration and failure of the driveline and attaching components. Failure of a driveline can result in separation of driveline from vehicle. A separated driveline can result in property damage, serious personal injury or death.

14. Install bearing retainers or **new** stamped straps and **new** bolts. (See photo 150, page 144). Torque the bolts down evenly and to required specifications. Check to make sure the bearing cup assemblies are fully seated in yoke ears. Table ZZ, Page 144. ▲ See warning, below.

▲ ***WARNING***

Failure to install new stamped straps, new bolts and torque bolts to specification can cause driveline failure, which can result in separation of the driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.

15. It may be necessary to collapse the slip member assembly to allow clearance to install driveshaft into the center bearing end yoke. Use a soft-faced hammer to tap universal joint into center bearing end yoke, matching up phasing marks made during removal to ensure original driveshaft orientation. ▲ See warning, below.

▲ ***WARNING***

Improperly seated bearing cup assemblies can cause driveline failure which can result in separation of the driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.

16. Install bearing retainers or **new** stamped straps and **new** bolts. Torque the bolts down evenly and to required specifications. Check to make sure the bearing cup assemblies are fully seated in yoke ears. Reference bolt specifications, Table AAA, above. ▲ See warnings, steps 14 and 15.

QUICK DISCONNECT BOLT SPECIFICATIONS

SERIES	BOLT P/N*	THREAD SIZE	HEAD SIZE	BOLT TORQUE Nm	BOLT TORQUE LB. FT.
SPL55	TBD	TBD	TBD	TBD	TBD
SPL70	TBD	TBD	TBD	TBD	TBD
SPL90	6-73-412	0.375 in. - 24	3/8 in. 12 point	61-81	45-60
SPL100	TBD	TBD	TBD	TBD	TBD
SPL140	12-73-125M	12mm - 1.25	12 mm 12 point	135-160	100-120
SPL170	12-73-125M	12mm - 1.25	12 mm 12 point	135-160	100-120
SPL250	12-73-125M	12mm - 1.25	12 mm 12 point	135-160	100-120

** Bolts are specially heat-treated.*
DO NOT substitute inferior grade bolts.

Table AAA

17. Completely relubricate all the universal joints and the slip member assembly (if slip member assembly is relubable) as described in the lubrication section of this manual.

18. Remove **all** support straps.

Outboard Slip Style

19. Guide slip yoke onto midship stub shaft, **making sure phasing marks made during removal are in line**. ▲ See warning, below.

▲ ***WARNING***

Installation of a driveline out of original phase can cause vibration and failure of the driveline and attaching components. Failure of a driveline can result in separation of driveline from vehicle. A separated driveline can result in property damage, serious personal injury or death.

20. Using a soft-faced hammer to tap universal joint into rear end yoke, match up phasing marks made during removal to ensure original driveshaft orientation. ▲ See warning, step 19.

21. Install the bearing retainers or **new** stamped straps and **new** bolts. Torque the bolts down evenly and to required specifications. Check to make sure the bearing cup assemblies are fully seated in the yoke ears. See warning, below.

WARNING

Improperly seated bearing cup assemblies can cause driveline failure which can result in separation of the driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.

Reference bolt specifications, page 145. Bolts must be torqued to required specifications. See warning, below.

WARNING

Failure to install new stamped straps and new bolts and to torque bolts to specification can cause driveline failure, which can result in separation of the driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.

22. Completely relubricate all the universal joints and the slip member assembly (if slip member assembly is relubable) as described in the lubrication section of this manual.

23. Remove **all** support straps.

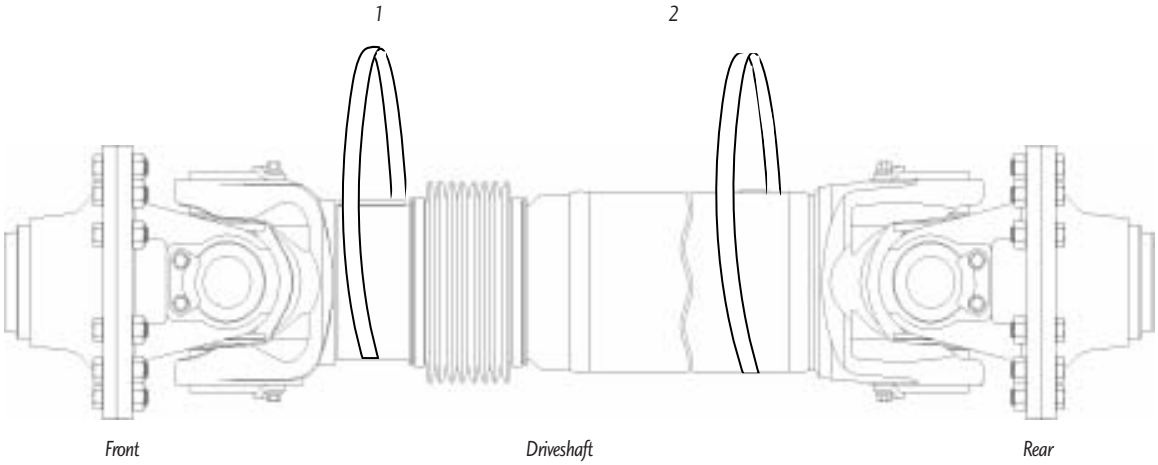


Figure CC, S.A.E.

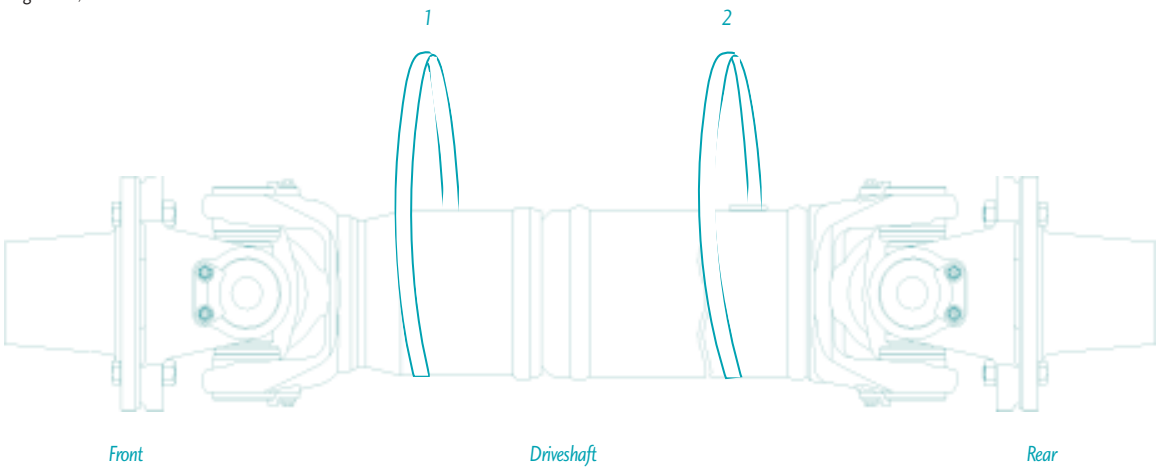


Figure DD, DIN and T-Type

COMPANION FLANGE/FLANGE YOKE STYLE (S.A.E, DIN AND T-TYPE)

One-Piece Driveshafts

Position Support Straps

1. Position support straps, as illustrated in Figure CC or DD, above, to make sure that the driveshaft will be properly supported. ▲ See warning, below.

▲ ***WARNING***

ALWAYS *use support straps to prevent driveshaft from falling out of vehicle. Failure to use support straps can cause damage to driveshaft or result in property damage, serious personal injury or death.*

Attach support straps to frame rails or some structural part of the vehicle. **DO NOT** attach the support straps to fuel lines, oil lines, brake lines, or wiring. **DO NOT** entangle fuel lines, oil lines, brake lines, or wiring in the support straps. ▲ See warning, below.

▲ ***WARNING***

Attaching or entangling support straps to fuel, oil or brake lines or wiring can result in their damage. Damaged fuel, oil or brake lines or wiring can result in failure of the vehicle, which can result in property damage, serious personal injury or death.

COMPANION FLANGE/FLANGE YOKE STYLE (S.A.E., DIN AND T-TYPE) HARDWARE SPECIFICATIONS

SERIES	BOLT P/N*†	WASHER P/N	NUT P/N	DIAMETER, THREAD & LENGTH UNDER HEAD	BOLT TORQUE Nm	BOLT TORQUE FT. LBS.
SPL55	TBD	TBD	TBD	TBD	TBD	TBD
SPL70	TBD	TBD	TBD	TBD	TBD	TBD
SPL90	6-73-1219	500357-11	231421-3	.375" 24 x 1.188"	54-65	40-48
SPL100	TBD	TBD	TBD	TBD	TBD	TBD
SPL140	6-73-220	500357-11	231421-3	.375" 24 x 1.250"	54-65	40-48
	6-73-1227	500357-11	231421-3	.375" 24 x 1.688"	54-65	40-48
SPL170	7-73-122	500357-12	231421-4	.438" 20 x 1.375"	85-102	63-75
	7-73-228	500357-12	231421-4	.438" 20 x 1.750"	85-102	63-75
SPL250	7-73-122	500357-12	231421-4	.438" 20 x 1.375"	85-102	63-75
	7-73-228	500357-12	231421-4	.438" 20 x 1.750"	85-102	63-75

**Bolts are specially heat-treated. DO NOT substitute inferior grade bolts.*
† Approved Spicer hardware.
***Note**-Original equipment vehicle manufacturers' manuals may have alternate specified bolts or metric hardware. Refer to the original equipment service manual for bolt part numbers.*

Table BBB

Install Driveshaft

2. Place the driveshaft in the support straps. **Be sure the driveshaft is placed back in its original orientation.** ▲ See warning, below.

▲ ***WARNING***

Installation of a driveline out of original phase can cause vibration and failure of the driveline and attaching components. Failure of a driveline can result in separation of driveline from vehicle. A separated driveline can result in property damage, serious personal injury or death.

Photo 151

3. Working from the **front end**, position the flange yoke face onto the companion flange, **aligning bolt holes and phasing marks**. Make sure flange yoke and companion flange are **free from grease** or other foreign material and properly seated. ▲ See warning, below.

▲ ***WARNING***

Improperly seated flange yoke and companion flanges can cause driveline failure, which can result in separation of the driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.

4. Install **new bolts**, washers (if required) and nuts. (See photo 151, above.) Reference hardware specifications, Table BBB, above. Bolts must be torqued to required specifications. ▲ See warning, below.

▲ ***WARNING***

Failure to torque bolts to specification can cause driveline failure, which can result in separation of the driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.

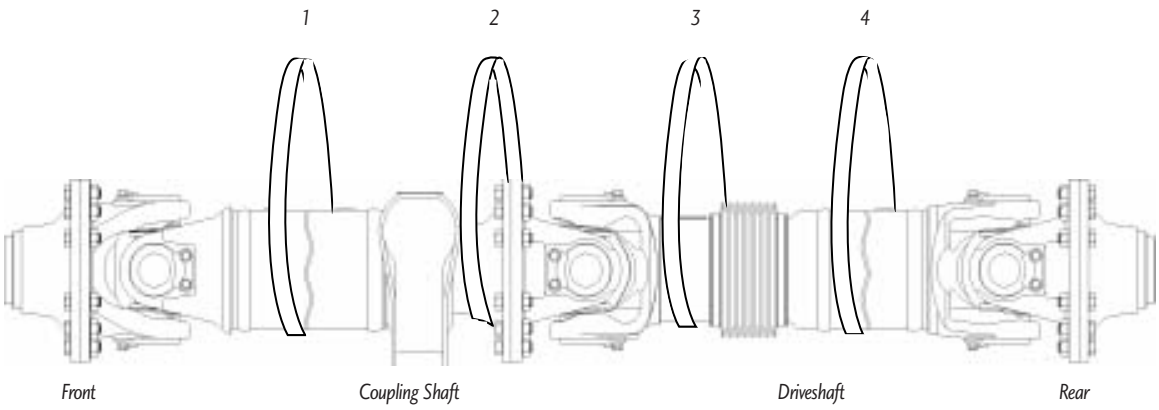


Figure EE, S.A.E.

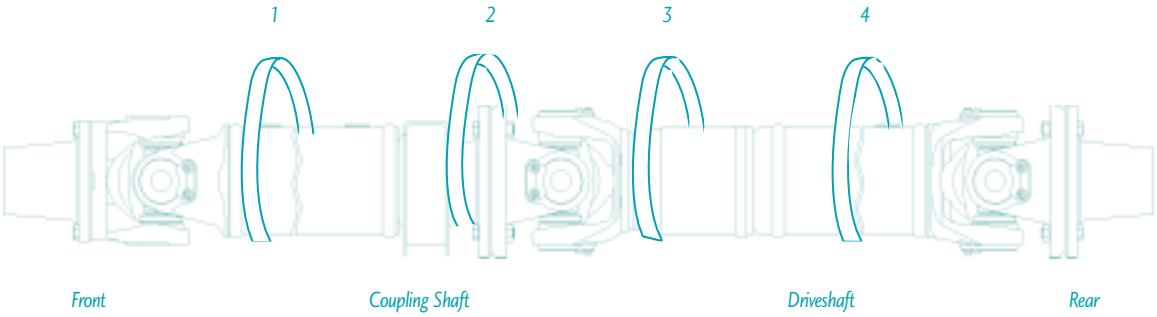


Figure FF, DIN and T-Type

5. **Be sure the second support strap is in place, as illustrated in Figure CC or DD, page 147.** It may be necessary to collapse slip member assembly to allow clearance to install the driveshaft into the front companion flange.

6. Repeat step 4.

7. Completely relubricate all universal joints and the slip member assembly (if slip member assembly is relubable) as described in the lubrication section of this manual.

8. Remove **all** support straps.

COMPANION FLANGE/FLANGE YOKE STYLE (S.A.E., DIN AND T-TYPE)

Two-Piece Driveshafts

Position Support Straps

1. Position support straps, as illustrated in Figure EE or FF, above, for the appropriate style driveshaft being serviced. Make sure that the driveshaft will be properly supported at the slip member, behind the center bearing end fitting and in front of center bearing, with support straps. ▲ See warning, below.

▲ ***WARNING***

ALWAYS *use support straps to prevent driveshaft from falling out of vehicle. Failure to use support straps can cause damage to driveshaft or result in property damage, serious personal injury or death.*

COMPANION FLANGE/FLANGE YOKE STYLE (S.A.E., DIN AND T-TYPE) HARDWARE SPECIFICATIONS

SERIES	BOLT P/N*†	WASHER P/N	NUT P/N	DIAMETER, THREAD & LENGTH UNDER HEAD	BOLT TORQUE Nm	BOLT TORQUE FT. LBS.
SPL55	TBD	TBD	TBD	TBD	TBD	TBD
SPL70	TBD	TBD	TBD	TBD	TBD	TBD
SPL90	6-73-1219	500357-11	231421-3	.375" 24 x 1.188"	54-65	40-48
SPL100	TBD	TBD	TBD	TBD	TBD	TBD
SPL140	6-73-220	500357-11	231421-3	.375" 24 x 1.250"	54-65	40-48
	6-73-1227	500357-11	231421-3	.375" 24 x 1.688"	54-65	40-48
SPL170	7-73-122	500357-12	231421-4	.438" 20 x 1.375"	85-102	63-75
	7-73-228	500357-12	231421-4	.438" 20 x 1.750"	85-102	63-75
SPL250	7-73-122	500357-12	231421-4	.438" 20 x 1.375"	85-102	63-75
	7-73-228	500357-12	231421-4	.438" 20 x 1.750"	85-102	63-75

**Bolts are specially heat-treated. DO NOT substitute inferior grade bolts.*
† Approved Spicer hardware.
***Note**-Original equipment vehicle manufacturers' manuals may have alternate specified bolts or metric hardware. Refer to the original equipment service manual for bolt part numbers.*

Table CCC

Attach support straps to frame rails or some structural part of the vehicle. **DO NOT** attach the support straps to fuel lines, oil lines, brake lines, or wiring. **DO NOT** entangle fuel lines, oil lines, brake lines, or wiring in the support straps. ▲ See warning, below.

▲ ***WARNING***

Attaching or entangling support straps to fuel, oil or brake lines or wiring can result in their damage. Damaged fuel, oil or brake lines or wiring can result in failure of the vehicle, which can result in property damage, serious personal injury or death.

Install Coupling Shaft

2. Place the **coupling shaft** in the first and second support straps. **Be sure the coupling shaft is placed back in its original orientation.** ▲ See warning, below.

▲ ***WARNING***

Installation of a driveline out of original phase can cause vibration and failure of the driveline and attaching components. Failure of a driveline can result in separation of driveline from vehicle. A separated driveline can result in property damage, serious personal injury or death.

3. Working from the **front** end, position the flange yoke face onto the companion flange, **aligning bolt holes and phasing marks**. Make sure the flange yoke and companion flange are **free from grease** or other foreign material and properly seated. ▲ See warning, below.

▲ ***WARNING***

Improperly seated flange yoke and companion flanges can cause driveline failure, which can result in separation of the driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.

4. Install **new** bolts, washers (if required) and nuts. (See photo 152, page 151.) Reference hardware specifications, Table CCC, above. Bolts must be torqued to required specifications. ▲ See warning, below.

▲ ***WARNING***

Failure to torque bolts to specification can cause driveline failure, which can result in separation of the driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.

Photo 152

5. **Be sure the second support strap is in place, as illustrated in Figures EE or FF, page 149**. Lift the center bearing to the center bearing bracket on the cross member of the frame. Install proper center bearing bracket bolts per vehicle manufacturer's recommendations. Torque bolts to vehicle manufacturer's specifications. ▲ See warning, below.

▲ ***WARNING***

Failure to torque bolts to specification can cause driveline failure, which can result in separation of the driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.

Install Driveshaft

6. **Be sure the third and fourth support straps are in place, as illustrated in Figures EE or FF, Page 149.** Place driveshaft in support straps. **Be sure the driveshaft is placed back in its original orientation.** ▲ See warning, below.

▲ ***WARNING***

Installation of a driveline out of original phase can cause vibration and failure of the driveline and attaching components. Failure of a driveline can result in separation of driveline from vehicle. A separated driveline can result in property damage, serious personal injury or death.

7. Working from the **rear end**, position the flange yoke face onto the companion flange, **aligning bolt holes and phasing marks**. Make sure the flange yoke and companion flange are **free from grease** or other foreign material and properly seated. ▲ See warning, below.

▲ ***WARNING***

An improperly seated flange yoke and companion flange can cause driveline failure, which can result in separation of the driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.

8. Install **new** bolts, washers (if required) and nuts. Reference hardware specifications, Table CCC, page 150. Bolts must be torqued to required specifications. ▲ See warning, step 5.

9. It may be necessary to collapse slip member assembly to allow clearance to install the driveshaft into the center bearing companion flange.

10. At center bearing, position the flange yoke face onto the companion flange, **aligning bolt holes and phasing marks.** Make sure the flange yoke and companion flange are free from grease or other foreign material and properly seated. ▲ See warning, step 7.

11. Install **new** bolts, washers (if required) and nuts. Reference appropriate hardware specifications, Table CCC, page 150. Bolts must be torqued to required specifications. ▲ See warning, step 5.

12. Completely relubricate all universal joints and the slip member assembly (if slip member assembly is relubable) as described in the lubrication section of this manual.

13. Remove **all** support straps.

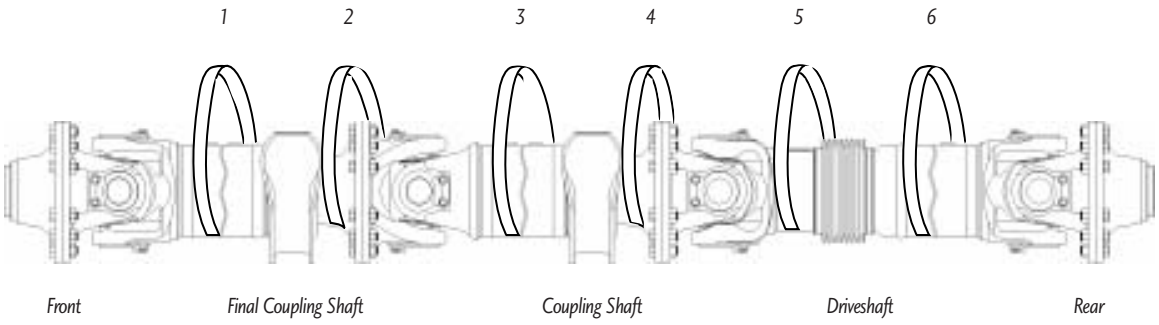


Figure GG

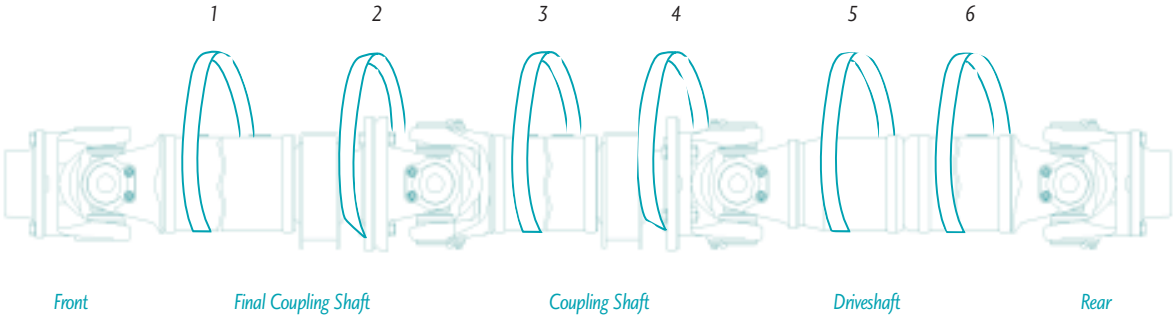


Figure HH

COMPANION FLANGE/FLANGE YOKE STYLE (S.A.E, DIN AND T-TYPE)

Multiple-Piece Driveshaft

Position Support Straps

1. Position support straps, as illustrated in Figure GG or HH, above, for appropriate style driveshaft being serviced. Make sure that the driveshaft will be properly supported at the slip member, behind the center bearing end fittings and in front of center bearings, with support straps. ▲ See warning, below.

▲ ***WARNING***

ALWAYS *use support straps to prevent driveshaft from falling out of vehicle. Failure to use support straps can cause damage to driveshaft or result in property damage, serious personal injury or death.*

Attach support straps to frame rails or some structural part of the vehicle. **DO NOT** attach the support straps to fuel lines, oil lines, brake lines, or wiring. **DO NOT** entangle fuel lines, oil lines, brake lines, or wiring in the support straps. ▲ See warning, below.

▲ ***WARNING***

Attaching or entangling support straps to fuel, oil or brake lines or wiring can result in their damage. Damaged fuel, oil or brake lines or wiring can result in failure of the vehicle, which can result in property damage, serious personal injury or death.

2. When working with multiple-piece driveshafts, start at the **front** to install all **coupling shafts**.

COMPANION FLANGE/FLANGE YOKE STYLE (S.A.E., DIN AND T-TYPE) HARDWARE SPECIFICATIONS

SERIES	BOLT P/N*†	WASHER P/N	NUT P/N	DIAMETER, THREAD & LENGTH UNDER HEAD	BOLT TORQUE Nm	BOLT TORQUE FT. LBS.
SPL55	TBD	TBD	TBD	TBD	TBD	TBD
SPL70	TBD	TBD	TBD	TBD	TBD	TBD
SPL90	6-73-1219	500357-11	231421-3	.375" 24 x 1.188"	54-65	40-48
SPL100	TBD	TBD	TBD	TBD	TBD	TBD
SPL140	6-73-220	500357-11	231421-3	.375" 24 x 1.250"	54-65	40-48
	6-73-1227	500357-11	231421-3	.375" 24 x 1.688"	54-65	40-48
SPL170	7-73-122	500357-12	231421-4	.438" 20 x 1.375"	85-102	63-75
	7-73-228	500357-12	231421-4	.438" 20 x 1.750"	85-102	63-75
SPL250	7-73-122	500357-12	231421-4	.438" 20 x 1.375"	85-102	63-75
	7-73-228	500357-12	231421-4	.438" 20 x 1.750"	85-102	63-75

**Bolts are specially heat-treated. DO NOT substitute inferior grade bolts.*
† Approved Spicer hardware.
***Note**-Original equipment vehicle manufacturers' manuals may have alternate specified bolts or metric hardware. Refer to the original equipment service manual for bolt part numbers.*

Table DDD

Install Final Coupling Shaft

3. Place final **coupling shaft** in the first and second support straps. **Be sure the coupling shaft is placed back in its original orientation.** ▲ See warning, below.

▲ ***WARNING***

Installation of a driveline out of original phase can cause vibration and failure of the driveline and attaching components. Failure of a driveline can result in separation of driveline from vehicle. A separated driveline can result in property damage, serious personal injury or death.

4. Working from the **front** end, position the flange yoke face onto the companion flange, **aligning bolt holes and phasing marks**. Make sure the flange yoke and companion flange are **free from grease** or other foreign material and properly seated. ▲ See warning, below.

▲ ***WARNING***

Improperly seated flange yoke and companion flanges can cause driveline failure, which can result in separation of the driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.

Photo 153

5. Install **new** bolts, washers (if required) and nuts. (See photo 153, above.) Reference hardware specifications, Table DDD, above. Bolts must be torqued to required specifications. ▲ See warning, below.

▲ ***WARNING***

Failure to torque bolts to specification can cause driveline failure, which can result in separation of the driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.

153

COMPANION FLANGE/FLANGE YOKE STYLE (S.A.E., DIN AND T-TYPE) HARDWARE SPECIFICATIONS

SERIES	BOLT P/N*†	WASHER P/N	NUT P/N	DIAMETER, THREAD & LENGTH UNDER HEAD	BOLT TORQUE Nm	BOLT TORQUE FT. LBS.
SPL55	TBD	TBD	TBD	TBD	TBD	TBD
SPL70	TBD	TBD	TBD	TBD	TBD	TBD
SPL90	6-73-1219	500357-11	231421-3	.375" 24 x 1.188"	54-65	40-48
SPL100	TBD	TBD	TBD	TBD	TBD	TBD
SPL140	6-73-220	500357-11	231421-3	.375" 24 x 1.250"	54-65	40-48
	6-73-1227	500357-11	231421-3	.375" 24 x 1.688"	54-65	40-48
SPL170	7-73-122	500357-12	231421-4	.438" 20 x 1.375"	85-102	63-75
	7-73-228	500357-12	231421-4	.438" 20 x 1.750"	85-102	63-75
SPL250	7-73-122	500357-12	231421-4	.438" 20 x 1.375"	85-102	63-75
	7-73-228	500357-12	231421-4	.438" 20 x 1.750"	85-102	63-75

**Bolts are specially heat-treated. DO NOT substitute inferior grade bolts.*
† Approved Spicer hardware.
***Note**-Original equipment vehicle manufacturers' manuals may have alternate specified bolts or metric hardware. Refer to the original equipment service manual for bolt part numbers.*

Table EEE

6. **Be sure to second support strap is in place as illustrated in Figures GG or HH, page 152**. Lift the center bearing to the center bearing bracket on the cross member of the frame. Install proper center bearing bracket bolts per vehicle manufacturer's recommendations. Torque bolts to vehicle manufacturer's required specifications. ▲ See warning, below.

▲ ***WARNING***

Failure to torque bolts to specification can cause driveline failure, which can result in separation of the driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.

Install Coupling Shaft(s)

7. **Be sure third and fourth support straps are in place, as illustrated in Figures GG or HH, Page 152.** Place coupling shaft in support straps. Be sure the coupling shaft is placed back in its original orientation. ▲ See warning, top right.

▲ ***WARNING***

Installation of a driveline out of original phase can cause vibration and failure of the driveline and attaching components. Failure of a driveline can result in separation of driveline from vehicle. A separated driveline can result in property damage, serious personal injury or death.

8. Working from the center bearing end fitting, position the flange yoke face onto the companion flange, **aligning bolt holes and phasing marks**. Make sure the flange yoke and companion flange are **free from grease** or other foreign material and properly seated. ▲ See warning, below.

▲ ***WARNING***

Improperly seated flange yoke and companion flanges can cause driveline failure, which can result in separation of the driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.

9. Install **new** bolts, washers (if required) and nuts. Reference hardware specifications, Table EEE, page 154. Bolts must be torqued to required specifications. ▲ See warning, below.

▲ ***WARNING***

Failure to torque bolts to specification can cause driveline failure, which can result in separation of the driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.

10. **Be sure the fourth support strap is in place, as illustrated in Figures GG or HH, Page 152.** Lift the center bearing to the center bearing bracket on the cross member of the frame. Install and torque center bearing bracket bolts per vehicle manufacturer's recommendations. ▲ See warning, Step 12.

11. Repeat Steps 7 through 10 as necessary to install any remaining coupling shafts.

Install Driveshaft

12. Place the **driveshaft** in the fifth and sixth support straps. **Be sure the driveshaft is placed back in its original orientation.** ▲ See warning, below.

▲ ***WARNING***

Installation of a driveline out of original phase can cause vibration and failure of the driveline and attaching components. Failure of a driveline can result in separation of driveline from vehicle. A separated driveline can result in property damage, serious personal injury or death.

13. Working from the **rear end**, position the flange yoke face onto the companion flange, **aligning bolt holes and phasing marks**. Make sure the flange yoke and companion flange are **free from grease** or other foreign material and properly seated. ▲ See warning, above right.

▲ ***WARNING***

An improperly seated flange yoke and companion flange can cause driveline failure, which can result in separation of the driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.

14. Install **new** bolts, washers (if required) and nuts. Reference hardware specifications, Table EEE, page 154. Bolts must be torqued to required specifications. ▲ See warning, step 9.

15. It may be necessary to collapse slip member assembly to allow clearance to install the driveshaft into the center bearing companion flange.

16. At center bearing, position the flange yoke face onto the companion flange, **aligning bolt holes and phasing marks**. Make sure the flange yoke and companion flange are **free from grease** or other foreign material and properly seated. ▲ See warning, step 13.

17. Install **new** bolts, washers (if required) and nuts. Reference hardware specifications, Table EEE, page 154. Bolts must be torqued to required specifications. ▲ See warning, step 9.

18. Completely relubricate all universal joints and slip member assemblies (if slip member assemblies are relubable) as described in the lubrication section of this manual.

19. Remove **all** support straps.

TABLE OF CONTENTS

SPICER LIFE SERIES™
LUBRICATION OF U-JOINTS, SLIP MEMBERS & CENTER BEARINGS

Before You Get Started

Note – Spicer Life Series™ driveshafts are found on vehicles throughout the world. Therefore, this manual includes worldwide terminology. These terms have been highlighted in teal.

Caution – Under no circumstances should individuals attempt to perform driveline service and/or maintenance procedures for which they have not been trained or do not have the proper tools and equipment. ▲ See warning, below.

▲ ***WARNING***

Failure to take commonsense, precautionary measures when working on a vehicle or other machinery could result in property damage, serious personal injury or death. In order to avoid property damage, serious personal injury or death, you must:

1. **ALWAYS** wear safety glasses when performing maintenance or service. Failure to wear safety glasses can result in personal injury and/or partial or complete vision loss.

2. **NEVER** go under a vehicle while the engine is running. Be sure the vehicle's engine is off, and keys are removed from ignition.

3. **NEVER** go under or work on a vehicle that is not on a level or flat surface.

4. **NEVER** work on a driveshaft without blocking the vehicle's wheels and releasing all parking brakes. ▲ See warning, below.

▲ ***WARNING***

Failure to release all parking brakes and failure to place transmission in neutral can result in torque being applied to the driveshaft. Disconnecting a driveshaft with applied torque can result in property damage, serious personal injury or death.

5. **NEVER** lift a vehicle without the appropriate weight-rated, vehicle-support equipment.

6. **NEVER REMOVE** a driveshaft from the vehicle without keeping the vehicle's transmission in neutral. ▲ See warning, step 4.

7. **CAUTION** – Spicer Life Series™ driveshaft assemblies can weigh in excess of 100 pounds (46 kilograms). Be sure to use proper lifting techniques when handling Spicer Life Series driveshafts. More than one person may be needed when handling driveshaft assemblies.

8. **ALWAYS** use support straps to prevent the driveshaft from falling out of vehicle during the removal and installation process.

9. **NEVER** heat components or use sledgehammers or floor jacks to remove the driveshaft from vehicle.

Note – For driveshaft applications that have pillow blocks, dampers, parking brakes or retarders, refer to these component manufacturers' or the original equipment vehicle manufacturers' service manuals for proper procedures.

Note – Spicer Life Series™ 140, 170 and 250 driveshaft assemblies and components are metric. To eliminate any confusion between S.A.E. and metric threaded fasteners, the metric fasteners have been color coded gold. Spicer Life metric fasteners include spring tab bolts, bearing retainer bolts and midship nuts.

LUBRICATION

SPICER LIFE SERIES™ 55, 70, 90, 100, 140, 170 & 250

Lack of proper lubrication is one of the most common causes of universal joint and slip member problems. When properly applied, relubable Spicer Life™ universal joints which are adequately relubricated at recommended intervals will meet or exceed vehicle operation requirements.

Note – Spicer Life Series™ replacement universal joint kits contain only enough grease to provide needle roller bearing protection during storage. It is therefore necessary to completely lubricate each replacement kit prior to assembly into the yokes.

Inadequate relubrication intervals and failure to properly lubricate the universal joints will cause universal joint failures. Proper relubrication flushes the universal joints, thus removing abrasive contaminants from the bearings. Relubable slip members must also be adequately relubricated to prevent slip member failure. ▲ See warning, below.

▲ ***WARNING***

Inadequate lubrication can cause driveline failure which can result in separation of the driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death. In order to avoid driveline failure, including driveline separation, you must:

1. Carefully review the lubrication specifications found in this manual.
2. Be sure that you relubricate at the recommended intervals.
3. Be sure that you use only recommended lubricants that meet the criteria listed.
4. Carefully follow driveshaft inspection procedures as outlined in this manual.

RECOMMENDED LUBRICANTS FOR RELUBABLE UNIVERSAL JOINTS AND SLIP MEMBERS

Standard Application

Spicer recommends that the following requirements be met for any lubricant that will be used to service most vehicular, industrial and all auxiliary driveshaft applications.

- Use a good quality **E.P. (extreme pressure)** grease
- Timkin Test Load - 50 Lbs./23 Kg. **minimum**
- Meeting N.L.G.I.,* E.P., **Grade 2** specifications
- Grease must have an operating range of +325˚F to -10˚F (+163˚C to -23˚C)

**National Lubricating Grease Institute*

Consult your local lubricant source for greases that meet these specifications.

Note – There are numerous instances when special lubrication is required by vehicle specifications or customer request. The lubrication recommendations listed in this manual are prescribed by Spicer Driveshaft Division engineering. Any alternate lubricants, or lubrication procedures, are the responsibility of the user.

GREASE COMPATIBILITY*

When greases made from different thickeners are mixed, the mixture may result in lower service performance or physical properties than either of the original component products. This reduction in lubricant performance is called incompatibility. It may show up in any of several areas, such as:

1. Lower heat resistance;
2. Change in consistency, usually softening; or
3. Decrease in shear stability.

Mixtures which show none of these changes are considered compatible. Incompatibility is not always caused by the thickener, since each of the greases in the mixture is a complete package – thickener, fluid, and additives. Sometimes the thickener of one grease is incompatible with the fluid or the additives present in the second grease. If the mixture proves to be significantly softer, less shear stable, or less heat resistant than the original grease, the mixture shall be deemed incompatible. ▲ See warning, below.

▲ ***WARNING***

Incompatible lubricants/greases which are applied to universal joints and/or slip members, can result in failure of the driveline and can result in separation of the driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.

Incompatibility is best determined in service or in service-related tests; it is not predictable. Certain thickener combinations often have been found unsatisfactory and are generally so recognized. These would include lithium and sodium greases and organo-clay and most soap greases. **Contact your local lubricant supplier for grease compatibility information.**

To help reduce the effects of incompatible greases, make sure to thoroughly purge all four bearing seals on each universal joint with the new grease. Purge seals until the **fresh** grease is visible on the outside of all four bearing seals.

It is recommended that all purged grease be wiped clean to prevent discharge into the general environment.

** Grease compatibility information – from National Lubricating Grease Institute*

LUBRICATION INTERVALS FOR RELUBABLE UNIVERSAL JOINTS

SPICER LIFE SERIES™ 55, 70, 90, 100, 140, 170 & 250

Lubrication intervals vary depending on the service requirements and operating conditions of the vehicle or machine. Table F, below, shows the recommended universal joint lubrication intervals for various types of service.

UNIVERSAL JOINT MAXIMUM LUBRICATION INTERVALS

SERIES	CITY	ON-HWY.	LINEHAUL	OFF-HWY.*	INDUSTRIAL*
SPL 250, 170 & 140	25,000 Mi. 40,000 Km. or 3 Months (which ever comes first)	100,000 Mi. 160,000 Km. or 6 Months (which ever comes first)	100,000 Mi. 160,000 Km. or 6 Months (which ever comes first)	25,000 Mi. 40,000 Km. or 3 Months (which ever comes first)	500 Hrs.
SPL 100, 90, 70 & 55	8,000 Mi. 12,800 Km. or 3 Months (which ever comes first)	15,000 Mi. 24,000 Km. or 3 Months (which ever comes first)	15,000 Mi. 24,000 Km. or 3 Months (which ever comes first)	8,000 Mi. 12,800 Km. or 3 Months (which ever comes first)	500 Hrs.

City *is defined as all applications that require a minimum of 90% of operation time within city limits.*

On-highway *is defined as all applications requiring less than 10% of operating time on gravel, dirt or unpaved roads.*

Off-highway *is defined as all applications requiring more than 10% of operating time on gravel, dirt or unpaved roads.*

Linehaul *is defined as 100% of operation time on smooth concrete or asphalt.*

** Relubrication intervals for off-highway and industrial use vary depending on the application and operating conditions. In general, to obtain maximum life, relubrication on industrial applications should occur every 500 hours for normal service and every 250 hours for continuous service or severe environmental conditions.*

Table F

LUBRICATION PROCEDURE FOR UNIVERSAL JOINTS

SPICER LIFE SERIES™ 55,70, 90, 100, 140, 170 & 250

Required Tools

- N.L.G.I. Grade-2, E.P. Grease
- Grease Gun

May Need – If bearing(s) will not purge

- Ratchet or Air Gun
- Appropriate 12-Point Socket
- C-Clamp
- Extra Bearing Retainer or Stamped Strap Bolts
- Extra Stamped Straps
- Brass Hammer or Soft-Faced Hammer

1. Use the recommended lubricant to purge **all** four seals of each universal joint. This flushes abrasive contaminants from each bearing assembly and assures proper filling of all four bearings.

Make sure **fresh** grease is evident at all universal joint bearing seals. (See photo 14, below.)

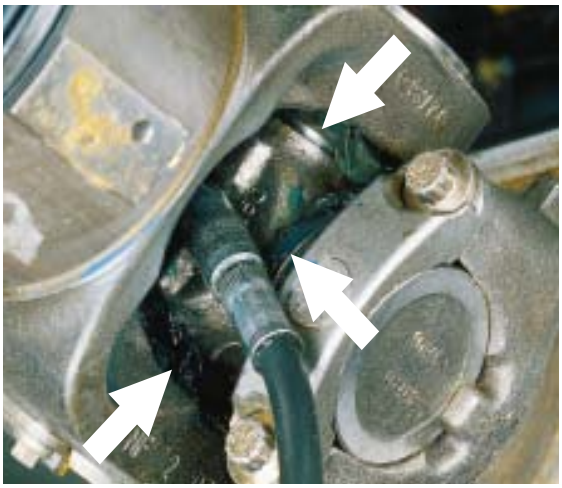


Photo 14

2. If any of the seals fail to purge, try to move the driveshaft from side to side while applying grease gun pressure. On two-headed zerk (nipple) fittings, try greasing from the opposite lube fitting.

Note – Due to the superior sealing capability of the Spicer Life design, there will occasionally be one or more bearing assembly seals that will not purge.

3. If any bearing cup assemblies fail to purge, releasing seal tension may be necessary. See table of contents for page listings for releasing seal tension of Quick Disconnect,™ Companion Flange/Flange Yoke (S.A.E., DIN and T-Type) or Snap Ring Styles.

PROCEDURE FOR RELEASING UNIVERSAL JOINT BEARING SEAL TENSION

QUICK DISCONNECT™ – SPRING TAB STYLE

Note – It will be necessary to have additional bearing retainer or stamped strap bolts and stamped straps in order to complete the following instructions. It may also be necessary to have additional spring tabs and spring tab bolts.

1. Utilizing a brass hammer and wearing safety glasses, sharply strike inboard yoke on lug ear **once**, to firmly seat bearing against spring tab and relieve tension across span. ▲ See warning, below. Rotate shaft 180 degrees and repeat procedure on opposite lug ear.

Apply grease gun pressure and purge **all** four bearings until **fresh grease** is seen at **all** four bearing seals.

▲ ***WARNING***

To prevent serious eye injury, always wear safety glasses when performing maintenance or service. Failure to wear safety glasses can result in serious personal injury, partial or complete vision loss.

2. If striking lug ears does not cause purging, remove and discard spring tab bolts and spring tabs. ▲ See warning, below. Repeat step 1.

▲ ***WARNING***

Failure to properly tighten bolts, reuse of spring tabs, reuse of spring tab bolts, or use of inferior grade bolts can result in separation of the driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.

If **all** four bearings purge fresh grease, **replace used spring tabs and spring tab bolts with new**. Torque spring tab bolts to required specifications. (See Table G, below.) ▲ See warning, step 2.

SPRING TAB BOLT SPECIFICATIONS

SERIES	THREAD SIZE	HEAD SIZE	BOLT TORQUE* Nm	BOLT TORQUE* LB. FT.	KIT P/N
SPL 140	8mm-1.00	8mm, 6 point	35-40	20-25	211941X
SPL 170	8mm-1.00	8mm, 6 point	35-40	20-25	211941X
SPL 250	8mm-1.00	8mm, 6 point	35-40	20-25	211941X

**Spicer bolts are specially heat-treated.*
***DO NOT** substitute with inferior grade bolts.*

Table G

If bearings still do not purge, removal of the universal joint kit from the end yoke is needed to determine cause of blockage. Follow steps 3-10 for proper removal of universal joint kit from end yoke.

Mark Driveshaft ("Phasing Marks")

3. With a marking stick, paint marker or other legible marking device, mark all bearing positions in relation to yokes and bearing retainers at the effected universal joint. (See figure A, page 27.) This assures proper reassembly of the driveshaft into the vehicle, in its original position. ▲ See warning, below.

▲ ***WARNING***

Reassembly of a driveline out of original phase can cause vibration and failure of the driveline and attaching components. Failure of a driveline can result in separation of driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.

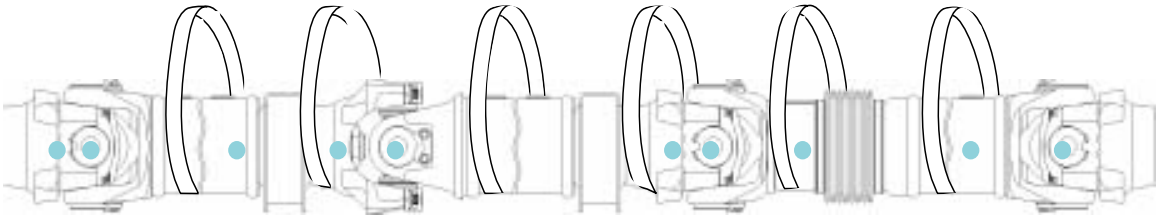


Figure A

Position Support Strap

4. Working at the effected universal joint, support the driveshaft with a support strap at the appropriate location, as illustrated in Figure A. Attach support straps to frame rails or some structural part of the vehicle. ▲ See warning, below.

▲ ***WARNING***

ALWAYS *use support straps to prevent driveshaft from falling out of vehicle. Failure to use a support strap can cause damage to driveshaft or result in property damage, serious personal injury or death.*

DO NOT attach the support straps to fuel lines, oil lines, brake lines, or wiring. **DO NOT** entangle fuel lines, oil lines, brake lines or wiring in the support straps. ▲ See warning, below.

▲ ***WARNING***

Attaching or entangling support straps to fuel, oil or brake lines or wiring can result in their damage. Damaged fuel, oil or brake lines or wiring can result in failure of the vehicle which can result in property damage, serious personal injury or death.

Disconnect Driveshaft

5. Remove the bearing retainers and bolts at the effected universal joint. Reference bolt specifications, Table H, page 28. (See photo 15, below.) Bearing retainer bolts with nylon lock patch **CANNOT** be reused. Loosening or removing bearing retainer bolts requires replacement of used bolts with new. ▲ See warning, below.

Photo 15

▲ ***WARNING***

DO NOT *reuse spring tabs, spring tab bolts, bearing retainer bolts, or use inferior grade bolts. Reuse of spring tabs, spring tab bolts, bearing retainer bolts or the use of inferior grade bolts can cause driveline failure, which can result in separation of driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.*

Note – New cold formed bearing retainers **DO NOT** need to be replaced. (See photo 16, below.) Replace only if damaged.

Photo 16, Bearing Retainers

BOLT SPECIFICATIONS – QUICK DISCONNECT™

SERIES	BOLT P/N*	THREAD SIZE	HEAD SIZE	BOLT TORQUE Nm	BOLT TORQUE LB. FT.
SPL 140	12-73-125M	12mm - 1.25	12mm, 12 point	135-160	100-120
SPL 170	12-73-125M	12mm - 1.25	12mm, 12 point	135-160	100-120
SPL 250	12-73-125M	12mm - 1.25	12mm, 12 point	135-160	100-120

** Spicer bolts are specially heat-treated.*
***DO NOT** substitute with inferior grade bolts.*

Table H

Photo 17

6. It may be necessary to unseat bearing cup assemblies by tapping on yoke or bearing cup with a soft-faced hammer. (See photo 17, above.) Once the bearing cup assemblies are free, allow the driveshaft to rest on support strap.

Purging Inboard Bearings

7. Apply a c-clamp around the outboard bearings. Apply grease gun pressure. Completely purge both inboard bearings. (See photo 18, below.)

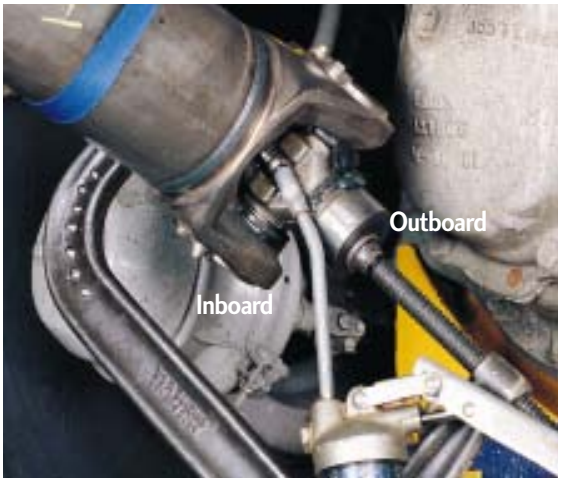


Photo 18

Purging Outboard Bearings

8. If outboard bearings fail to purge, slightly loosen c-clamp and reapply grease gun pressure until both outboard bearings purge.

9. After **all** four bearings purge fresh grease, re-tighten c-clamp to squeeze out excess grease and wipe clean. This will ease installation of universal joint kit back into yoke. Install universal joint kit in the yoke using new bearing retainer bolts, and torque bolts to the required specifications. Reference bolt torque specifications (Table H, page 28). ▲ See warning, below.

▲ ***WARNING***

DO NOT *reuse bearing retainer bolts or use inferior grade bolts. Reuse of bearing retainer bolts or the use of inferior grade bolts can cause driveline failure, which can result in separation of driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.*

10. If the bearings still will not purge, complete removal of the universal joint kit is needed to determine cause of blockage. See removal section of this manual for proper procedures on removing Spicer Quick Disconnect™ style driveshaft assemblies and spring tab style universal joints.

COMPANION FLANGE/FLANGE YOKE STYLE S.A.E., DIN AND T-TYPE

Note – It will be necessary to have additional flange bolts, nuts and washers (if applicable) in order to complete the following instructions. It may also be necessary to have additional spring tabs and spring tab bolts.

1. Utilizing a brass hammer and wearing safety glasses, sharply strike yoke on inboard and outboard lug ears **once**, to firmly seat bearings against spring tabs and relieve tension across span. ▲ See warning, below. Rotate shaft 180 degrees and repeat procedure on opposite inboard and outboard lug ears. (See photos 19 & 20, below.)

Apply grease gun pressure and purge **all** four bearings until **fresh grease** is seen at **all** four bearing seals.

▲ ***WARNING***

To prevent serious eye injury, always wear safety glasses when performing maintenance or service. Failure to wear safety glasses could result in serious personal injury, and/or partial or complete vision loss.

Photo 19

Photo 20

2. If striking lug ears does not cause purging, remove and discard spring tab bolts and spring tabs. Repeat step 1.

If **all** four bearings purge fresh grease, **replace used spring tabs and spring tab bolts with new.** Torque spring tab bolts to proper specifications. (See Table J, below.)
▲ See warning, below.

▲ ***WARNING***

Failure to properly tighten spring tab bolts, reuse of spring tabs, reuse of spring tab bolts, or use of inferior grade bolts, can cause the driveline to loosen and separate from the vehicle or machine. A separated driveline can result in property damage, serious personal injury or death.

SPRING TAB BOLT SPECIFICATIONS

SERIES	THREAD SIZE	HEAD SIZE	BOLT TORQUE Nm	BOLT TORQUE LB. FT.	KIT P/N*
SPL140	8mm - 1.00	8mm, 6 point	35-40	25-30	211941X
SPL170	8mm - 1.00	8mm, 6 point	35-40	25-30	211941X
SPL250	8mm - 1.00	8mm, 6 point	35-40	25-30	211941X

** Spicer bolts are specially heat-treated.*
***DO NOT** substitute with inferior grade bolts.*

Table J

3. If the bearings still do not purge, complete removal of the universal joint kit is needed to determine cause of blockage. See removal section of this manual for proper procedures on removing companion flange/flange yoke (S.A.E., DIN and T-Type) spring tab style driveshaft assemblies and universal joints.

SNAP RING STYLE

Note – For Quick Disconnect™ snap ring style driveshaft assemblies, it will be necessary to have additional stamped straps and stamped strap bolts to complete the following instructions. It may also be necessary to have additional snap rings.

Note – For companion flange/flange yoke, (S.A.E., DIN and T-Type), snap ring style driveshaft assemblies, it will be necessary to have additional flange bolts, nuts and washers (if applicable) to complete the instructions on page 33. It may also be necessary to have additional snap rings.

Quick Disconnect™ Style

1. Utilizing a brass hammer and wearing safety glasses, sharply strike inboard yoke on lug ear once to try to firmly seat bearing against spring tab and relieve tension across span. ▲ See warning, below. Rotate shaft 180 degrees and repeat procedure on opposite lug ear.

Apply grease gun pressure and purge **all** four bearings until **fresh grease** is seen at **all** four bearing seals.

▲ ***WARNING***

To prevent serious eye injury, always wear safety glasses when performing maintenance or service. Failure to wear safety glasses can result in serious personal injury, and/or partial or complete vision loss.

If striking lug ears does not cause purging, removal of the universal joint kit from the end yoke is needed to determine cause of blockage. Follow steps 2-9 for proper removal of universal joint kit from end yoke.

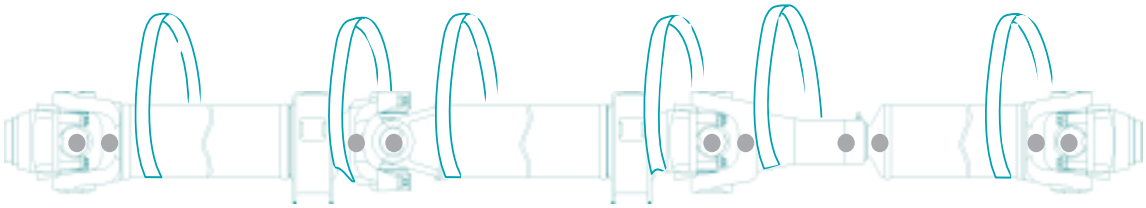


Figure B

Mark Driveshaft ("Phasing Marks")

2. With a marking stick, paint marker or other legible marking device, mark all bearing positions in relation to yokes at the effected universal joint as illustrated in figure B. This assures proper reassembly of the driveshaft into the vehicle, in its original position. ▲ See warning, below.

▲ ***WARNING***

Reassembly of a driveline out of original phase can cause vibration and failure of the driveline and attaching components. Failure of a driveline can result in separation of driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.

Position Support Strap

3. Working at the effected universal joint, support the driveshaft with a support strap at the appropriate location, as illustrated in Figure B, above. ▲ See warning, below.

▲ ***WARNING***

***ALWAYS** use support straps to prevent driveshaft from falling out of vehicle. Failure to use a support strap can cause damage to driveshaft or result in property damage, serious personal injury or death.*

Attach support straps to frame rails or some structural part of the vehicle. **DO NOT** attach the support straps to fuel lines, oil lines, brake lines, or wiring. **DO NOT** entangle fuel lines, oil lines, brake lines or wiring in the support straps. ▲ See warning, below.

▲ ***WARNING***

Attaching support straps to fuel, oil or brake lines or wiring can result in their damage. Damaged fuel, oil or brake lines or wiring can result in failure of the vehicle which can result in property damage, serious personal injury or death.

Disconnect Driveshaft

4. Remove bearing retainers or stamped straps (if applicable) at the effected universal joint. Discard bolts. Reference bolt specifications. (See Table K, right.) Stamped straps and stamped strap bolts or bearing retainer bolts **CANNOT** be reused. Loosening or removing bolts requires replacement of used bolts with new. Torque new bolts to required specifications. Reference bolt specifications. (See Table K, right.) ▲ See warning, below.

Note – New cold formed bearing retainers **DO NOT** need to be replaced. (See photo 21, below.) Replace only if damaged.

Note – Stamped straps **MUST BE** replaced. (See photo 22, below.) ▲ See warning, below.

Photo 21, Bearing Retainers

Photo 22, Stamped Straps

▲ ***WARNING***

DO NOT *reuse bearing retainer or stamped strap bolts, stamped straps, or use inferior grade bolts. Reuse of bearing retainer or stamped strap bolts, stamped straps and the use of inferior grade bolts can cause driveline failure, which can result in separation of driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.*

QUICK DISCONNECT™ BOLT SPECIFICATIONS

SERIES	BOLT P/N*	THREAD SIZE	HEAD SIZE	BOLT TORQUE Nm	BOLT TORQUE LB. FT.
SPL 55	TBD	TBD	TBD	TBD	TBD
SPL 70	TBD	TBD	TBD	TBD	TBD
SPL 90	6-73-412	0.375" - 24	3/8" 12 point	61-81	45-60
SPL 100	TBD	TBD	TBD	TBD	TBD

** Spicer bolts are specially heat-treated.*

Table K

5. It may be necessary to unseat bearing cup assemblies by tapping on yoke or bearing cup with a soft-faced hammer. Once the bearing cup assemblies are free, allow the driveshaft to rest on support strap.

Purging Inboard Bearings

6. Apply a c-clamp around the outboard bearings. Apply grease gun pressure. Completely purge both inboard bearings.

Purging Outboard Bearings

7. If outboard bearings fail to purge, slightly loosen c-clamp and reapply grease gun pressure until both outboard bearings purge.

8. After **all** four bearings purge fresh grease, re-tighten c-clamp to squeeze out excess grease and wipe clean. This will ease installation of universal joint kit back into yoke. Install universal joint kit, with new bolts, in the yoke and torque bolts to the required specifications. Reference bolt specifications. (See Table K, above.) ▲ See warning, step 4.

9. If bearings still will not purge, complete removal of the universal joint kit is needed to determine cause of blockage. See removal section of this manual for proper procedures on removing Spicer Quick Disconnect™ snap ring style driveshaft assemblies and universal joints.

Companion Flange/Flange Yoke (S.A.E., DIN and T-Type) Style

1. Utilizing a brass hammer and wearing safety glasses, sharply strike yoke on inboard and outboard lug ears **once**, to firmly seat bearings against snap rings and relieve tension across span. ▲ See warning, below. Rotate shaft 180 degrees and repeat procedure on opposite inboard and outboard lug ears.

Apply grease gun pressure and purge **all** four bearings until **fresh grease** is seen at **all** four bearing seals.

▲ ***WARNING***

To prevent serious eye injury, always wear safety glasses when performing maintenance or service. Failure to wear safety glasses can result in serious personal injury, and/or partial or complete vision loss.

2. If striking lug ears does not cause purging, remove snap rings in lug ears of the bearing(s) that are not purging. Repeat above instructions. If **all** four bearings purge fresh grease, replace snap rings.

Note – Spicer snap rings can be reused if they **ARE NOT** severely corroded or distorted. If corroded or distorted, replace used snap rings with new. (See Table L, below.)

OUTSIDE SNAP RINGS	P/N
SPL 55	TBD
SPL 70	TBD
SPL 90	5-7-29
SPL 100	TBD

Table L

3. If the bearings still do not purge, complete removal of the universal joint kit is needed to determine cause of blockage. See removal section of this manual for proper procedures on removing companion flange/flange yoke (S.A.E., DIN and T-Type) style driveshaft assemblies and snap ring style universal joints.

LUBRICATION INTERVALS FOR RELUBABLE SLIP MEMBERS

SPICER LIFE SERIES™ 90

Lubrication cycles vary depending on the service requirements and operating conditions of the vehicle or machine. Table M, below, shows a recommended lubrication cycle for slip members for various types of service.

SLIP MEMBER MAXIMUM LUBRICATION INTERVALS

SERIES	CITY	ON-HWY.	LINEHAUL	OFF-HWY.*	INDUSTRIAL*
SPL 90	8,000 Mi. 12,800 Km. or 3 Months (which ever comes first)	15,000 Mi. 24,000 Km. or 3 Months (which ever comes first)	15,000 Mi. 24,000 Km. or 3 Months (which ever comes first)	8,000 Mi. 12,800 Km. or 3 Months (which ever comes first)	500 Hrs.

City *is defined as all applications that require a minimum of 90% of operation time within city limits.*

On-highway *is defined as all applications requiring less than 10% of operating time on gravel, dirt or unpaved roads.*

Off-highway *is defined as all applications requiring more than 10% of operating time on gravel, dirt or unpaved roads.*

Linehaul *is defined as 100% of operation time on smooth concrete or asphalt.*

** Lubrication intervals for off-highway and industrial use vary depending on the application and operating conditions. In general, to obtain maximum life, lubrication on industrial applications should occur every 500 hours for normal service and every 200 hours for continuous service or severe environmental conditions.*

Table M

LUBRICATION PROCEDURE FOR RELUBABLE SLIP MEMBERS

SPICER LIFE SERIES™ 90

1. Apply grease gun pressure to the lube fitting until lubricant appears at the seal. Always use a E.P., Grade 2 specification, N.L.G.I grease, on Glidecote® and steel splines. Spicer recommends the same lubricant used for universal joints. Lubricate slip members at the lubrication intervals prescribed in Table M, page 34.

Caution – In cold temperatures, be sure to activate the slip member by driving the vehicle sufficiently to cause displacement of the grease prior to its stiffening. Failure to do so could cause the excess lubricant to stiffen in the cold weather and force the welch plug out. The end of the spline would then be open to collect contaminants and can result in driveline failure. ▲ See warning, below.

▲ ***WARNING***

A contaminated slip member can result in separation of the driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.

LUBRICATION FOR CENTER BEARINGS

SPICER LIFE SERIES™ 55, 70, 90, 100, 140, 170 & 250

All Spicer manufactured center bearings are permanently lubricated. No attempt should be made to add or change grease within the bearing itself.

However, when replacing a center bearing assembly, it is necessary to fill the entire cavity around the bearing with waterproof grease to shield the bearing from water and contaminants. The quantity of lubricant should be sufficient to fill the cavity to the extreme edge of the slinger surrounding the bearing. (See photo 23, below.)

Lubricants must be waterproof. See recommended lubricant Table N, below.

Photo 23

RECOMMENDED CENTER BEARING LUBRICANTS

LUBRICANT	SOURCE
Rykon Premium No. 3	Amoco Oil Company
Amolith 8516	Amoco Oil Company
Van Talgar No. 4	Exxon Company

Table N

Note – For relubable center bearings (pillow block) use original component manufacturer's recommended lubricants and lubrication intervals.

TABLE OF CONTENTS

SPICER LIFE SERIES™ DRIVESHAFT REMOVAL

Before You Get Started

Note – Spicer Life Series™ driveshafts are found on vehicles throughout the world. Therefore, this manual includes world-wide terminology. These terms have been highlighted in teal.

Caution – Under no circumstances should individuals attempt to perform driveline service and/or maintenance procedures for which they have not been trained or do not have the proper tools and equipment. ▲ See warning, below.

▲ ***WARNING***

Failure to take commonsense, precautionary measures when working on a vehicle or other machinery could result in property damage, serious personal injury or death. In order to avoid property damage, serious personal injury or death, you must:

1. **ALWAYS** wear safety glasses when performing maintenance or service. Failure to wear safety glasses can result in personal injury and/or partial or complete vision loss.

2. **NEVER** go under a vehicle while the engine is running. Be sure the vehicle's engine is off, and keys are removed from ignition.

3. **NEVER** go under or work on a vehicle that is not on a level or flat surface.

4. **NEVER** work on a driveshaft without blocking the vehicle's wheels and releasing all parking brakes. ▲ See warning, below.

▲ ***WARNING***

Failure to release all parking brakes and failure to place transmission in neutral can result in torque being applied to the driveshaft. Disconnecting a driveshaft with applied torque can result in property damage, serious personal injury or death.

5. **NEVER** lift a vehicle without the appropriate weight-rated, vehicle-support equipment.

6. **NEVER REMOVE** a driveshaft from the vehicle without keeping the vehicle's transmission in neutral. ▲ See warning, step 4.

7. **CAUTION** – Spicer Life Series™ driveshaft assemblies can weigh in excess of 100 pounds (46 kilograms). Be sure to use proper lifting techniques when handling Spicer Life Series driveshafts. More than one person may be needed when handling driveshaft assemblies.

8. **ALWAYS** use support straps to prevent the driveshaft from falling out of vehicle during the removal and installation process.

9. **NEVER** heat components or use sledgehammers or floor jacks to remove the driveshaft from vehicle.

Note – For driveshaft applications that have pillow blocks, dampers, parking brakes or retarders, refer to these component manufacturers' or the original equipment vehicle manufacturers' service manuals for proper procedures.

Servicing a Spicer Life Series™ Driveshaft

The following components are serviceable:

- Universal Joint Kits
- Boot Kits
- Quick Disconnect™ End Yokes
- S.A.E., DIN and T-Type Flange Yokes
- S.A.E., DIN and T-Type Companion Flanges
- Bearing Retainers and Bolts or Stamped Straps and Bolts
- Spring Tabs and Bolts
- Center Bearing Assemblies
- Grease Zerk (Nipple) Fittings

Note – Spicer Life Series™ 140, 170 and 250 driveshaft assemblies and components are metric. To eliminate any confusion between S.A.E. and metric threaded fasteners, the metric fasteners have been color coded gold. Spicer Life metric fasteners include spring tab bolts, bearing retainer bolts and midship nuts.

REMOVAL PROCEDURE FOR END FITTINGS

SPICER LIFE SERIES™ 55, 70, 90, 100, 140, 170 & 250

Refer to the transmission, axle or transfer case original equipment manufacturers' service and maintenance manuals for removal procedure.

Refer to the Table of Contents for removal of center bearing end fittings.

REMOVAL PROCEDURE FOR DRIVESHAFT ASSEMBLIES

SPICER LIFE SERIES™ 55, 70, 90, 100, 140, 170 & 250

Required Tools

- Ratchet or Air Gun
- Appropriate 12-Point Sockets
  - English 3/8"
  - Metric 12mm
- Bench Vice
- Soft-Faced Hammer
  Brass, Plastic or Rubber
- Support Straps
- Appropriate Spicer Alignment Bar (See photos 24 or 25)
- Emery cloth and/or fine-toothed file

Photo 24, Spicer Alignment Bar, Quick Disconnect Style

Photo 25, Spicer Alignment Bar, Companion Flange/Flange Yoke Style (S.A.E., DIN and T-Type)

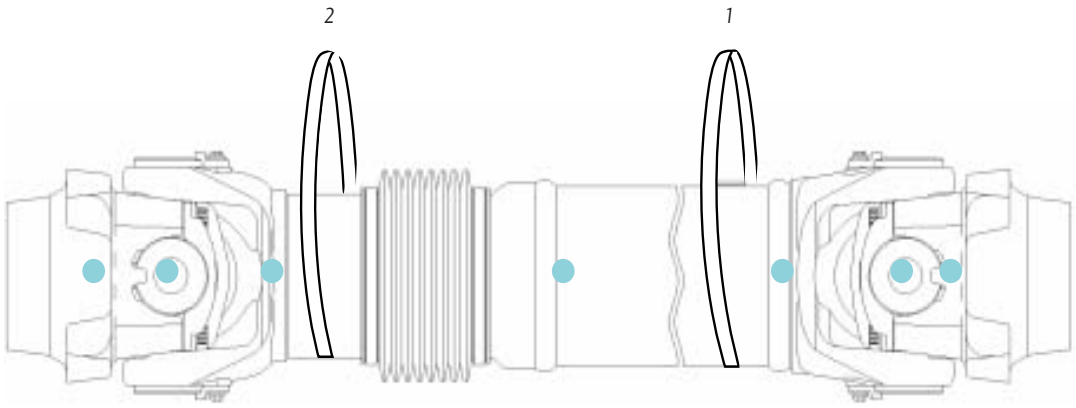


Figure C

QUICK DISCONNECT™ YOKE STYLE

One-Piece Driveshaft

Caution – Be sure to carefully read all information on page 39 before proceeding.

Mark Driveshaft ("Phasing Marks")

1. It is imperative to mark all the mating components of a driveshaft, as illustrated in Figure C, above. Mark the driveshaft with a marking stick, paint marker or other legible marking device. In addition, be sure to mark all bearing positions, spline positions, shaft locations and all bearing retainers. This assures proper reassembly of the driveshaft into the vehicle, in its original position. ▲ See warning, below.

▲ ***WARNING***

Reassembly of a driveline out of original phase can cause vibration and failure of the driveline and attaching components. Failure of a driveline can result in separation of driveline from the vehicle, which can result in property damage, serious personal injury or death.

Position Support Straps

2. Working from the **rear** end, support the driveshaft with support straps, as illustrated in Figure C, above. ▲ See warning, below.

▲ ***WARNING***

***ALWAYS** use support straps to prevent driveshaft from falling out of vehicle. Failure to use support straps can cause damage to driveshaft or result in property damage, serious personal injury or death.*

Attach support straps to frame rails or some structural part of the vehicle. **DO NOT** attach the support straps to fuel lines, oil lines, brake lines, or wiring. **DO NOT** entangle fuel lines, oil lines, brake lines, or wiring in the support straps. ▲ See warning, below.

▲ ***WARNING***

Attaching or entangling support straps to fuel, oil or brake lines or wiring can result in their damage. Damaged fuel, oil or brake lines or wiring can result in failure of the vehicle, which can result in property damage, serious personal injury or death.

Photo 26

Disconnect Driveshaft

3. **Be sure first support strap is in place as illustrated in figure C, page 41.** Remove the bearing retainers or stamped straps and bolts at rear end. Discard bolts. Discard stamped straps (if applicable). (See photo 26, above.) Reference bolt specifications, Table P, below.

QUICK DISCONNECT BOLT SPECIFICATIONS

SERIES	BOLT P/N*	THREAD SIZE	HEAD SIZE	BOLT TORQUE Nm	BOLT TORQUE LB. FT.
SPL55	TBD	TBD	TBD	TBD	TBD
SPL70	TBD	TBD	TBD	TBD	TBD
SPL90	6-73-412	0.375 in. - 24	3/8 in., 12 point	61-81	45-60
SPL100	TBD	TBD	TBD	TBD	TBD
SPL140	12-73-125M	12mm - 1.25	12 mm, 12 point	135-160	100-120
SPL170	12-73-125M	12mm - 1.25	12 mm, 12 point	135-160	100-120
SPL250	12-73-125M	12mm - 1.25	12 mm, 12 point	135-160	100-120

** Bolts are specially heat-treated.*
DO NOT substitute with inferior grade bolts.

Table P

Bearing retainers **CAN** be reused **if there is no damage**. (See photo 27, below.) If damaged, replace.

Photo 27, Bearing Retainers

Stamped straps **CANNOT** be reused. (See photo 28, below.) ▲ See warning, below.

Photo 28, Stamped Straps

▲ ***WARNING***

DO NOT *reuse bearing retainer bolts, stamped straps, stamped strap bolts, damaged bearing retainers, or use inferior grade bolts. Reuse of bearing retainer bolts, stamped straps, stamped strap bolts, damaged bearing retainers or the use of inferior grade bolts can cause driveline failure, which can result in separation of driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.*

Photo 29

4. It may be necessary to unseat bearing cup assemblies by tapping on yoke or bearing cup with a soft-faced hammer. (See photo 29, above.) Once the bearing cup assemblies are free, collapse the driveshaft until both bearing assemblies clear the open end yoke cross holes. Allow the driveshaft to rest on support strap.

Remove Driveshaft

5. **Be sure second support strap is in place as illustrated in Figure C, page 41**. Remove bearing retainers or stamped straps and bolts at the **front** end. Discard bolts. ▲ See warning, below.

▲ ***WARNING***

DO NOT *reuse bearing retainer bolts, stamped straps, stamped strap bolts, damaged bearing retainers, or use inferior grade bolts. Reuse of bearing retainer bolts, stamped straps, stamped strap bolts, damaged bearing retainers or the use of inferior grade bolts can cause driveline failure, which can result in separation of driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.*

6. It may be necessary to unseat bearing cup assemblies by tapping on yoke or bearing cup with a soft-faced hammer. Once the driveshaft is free, remove the driveshaft from the support straps and take it to a work bench area. ▲ See warning, below. Be sure to follow the end yoke inspection steps.

▲ ***WARNING***

Driveshaft assemblies can weigh in excess of 100 pounds (46 kilograms). Make sure to use proper lifting techniques when handling driveshafts. More than one person may be needed when handling driveshaft assemblies.

Inspect End Yokes

7. Check all end yokes for looseness. Take hold of end yoke with both hands. Try to move it vertically and horizontally to feel any looseness. There should **NOT** be any looseness in the end yokes relative to the input or output shafts to which they are connected. ▲ See warning, below.

▲ ***WARNING***

A loose end yoke can result in driveline failure, which can result in separation of driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.

If looseness is evident, the end yoke needs to be replaced. Refer to the transmission, axle or transfer case original equipment manufacturers' service and maintenance manuals for removal procedures.

8. Visually inspect all end yoke retaining nuts or bolts for any gaps between mating surfaces. See warning, below.

WARNING

A loose end yoke retaining nut or bolt can result in driveline failure, which can result in separation of driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.

If gaps are present, consult transmission, axle or transfer case original equipment manufacturers' specifications for proper fastening.

9. Inspect all end yoke cross hole surfaces and bolt hole threads for damage. If the bolt hole threads are damaged, the yoke must be replaced. See warning, below.

WARNING

Failure to replace damaged driveline components can cause driveline failure, which can result in separation of driveline from vehicle. A separated driveline can result in property damage, serious personal injury or death.

Refer to the transmission, axle or transfer case original equipment manufacturers' service and maintenance manuals for removal procedures.

Photo 30

Raised metal or fretting on open yoke cross holes can be removed with a fine-toothed file and/or emery cloth. (See photo 30, above.) See warning, below.

WARNING

***DO NOT** deform yoke cross holes by removing excessive metal. Raised metal or deformed yoke cross holes can be a cause of cross and bearing failure, which can result in separation of driveline from vehicle. A separated driveline can result in property damage, serious personal injury or death.*

Photo 31

10. Inspect the end yoke cross holes for distortion using the appropriate Spicer alignment bar. (See photo 31, above.) Slide alignment bar through both cross holes simultaneously. If alignment bar will not pass through both cross holes simultaneously, cross holes are distorted and end yoke must be replaced. ▲ See warning, below.

▲ ***WARNING***

Failure to replace damaged driveline components can cause driveline failure, which can result in separation of driveline from vehicle. A separated driveline can result in property damage, personal injury or death.

Refer to the transmission, axle or transfer case original equipment manufacturers' service and maintenance manuals for removal procedures.

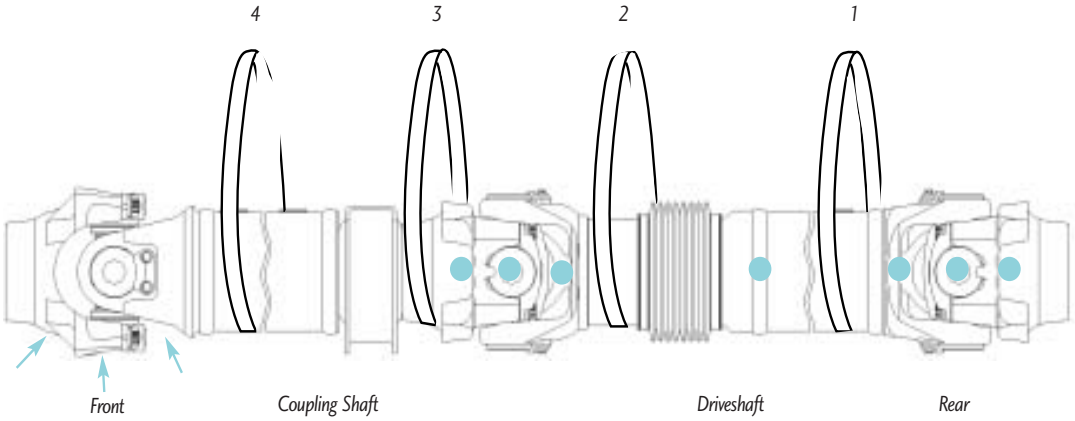


Figure D

QUICK DISCONNECT™ YOKE STYLE

Two-Piece Driveshaft

Caution – Be sure to carefully read all information on page 39 before proceeding.

Mark Driveshaft ("Phasing Marks")

1. It is imperative to mark all the mating components of a driveshaft, as illustrated in Figure D, above. Mark the driveshaft with a marking stick, paint marker or other legible marking device. In addition, be sure to mark all bearing positions, spline positions, shaft locations and all bearing retainers. This assures proper reassembly of the driveshaft into the vehicle, in its original position. ▲ See warning, below.

▲ ***WARNING***

Reassembly of a driveline out of original phase can cause vibration and failure of the driveline and attaching components. Failure of a driveline can result in separation of driveline from the vehicle, which can result in property damage, serious personal injury or death.

Position Support Straps

2. Working from the **rear** end, support the driveshaft with support straps as illustrated in Figure D, above. Be sure to support the shaft assembly at the rear, at the slip member, behind the center bearing end fitting and in front of center bearing, with support straps. ▲ See warning, below.

▲ ***WARNING***

ALWAYS *use support straps to prevent driveshaft from falling out of vehicle. Failure to use support straps can cause damage to driveshaft or result in property damage, serious personal injury or death.*

Attach support straps to frame rails or some structural part of the vehicle. **DO NOT** attach the support straps to fuel lines, oil lines, brake lines, or wiring. **DO NOT** entangle fuel lines, oil lines, brake lines, or wiring in the support straps. ▲ See warning, below.

▲ ***WARNING***

Attaching or entangling support straps to fuel, oil or brake lines or wiring can result in their damage. Damaged fuel, oil or brake lines or wiring can result in failure of the vehicle, which can result in property damage, serious personal injury or death.

Photo 32

Disconnect Driveshaft

3. **Be sure first support strap is in place as illustrated in figure D, page 46.** Remove the bearing retainers or stamped straps and bolts at **rear** end. Discard bolts. Discard stamped straps (if applicable). (See photo 32, above.) Reference bolt specifications, Table Q, below.

QUICK DISCONNECT™ BOLT SPECIFICATIONS

SERIES	BOLT P/N*	THREAD SIZE	HEAD SIZE	BOLT TORQUE Nm	BOLT TORQUE LB. FT.
SPL55	TBD	TBD	TBD	TBD	TBD
SPL70	TBD	TBD	TBD	TBD	TBD
SPL90	6-73-412	0.375 in. - 24	3/8 in., 12 point	61-81	45-60
SPL100	TBD	TBD	TBD	TBD	TBD
SPL140	12-73-125M	12mm - 1.25	12 mm, 12 point	135-160	100-120
SPL170	12-73-125M	12mm - 1.25	12 mm, 12 point	135-160	100-120
SPL250	12-73-125M	12mm - 1.25	12 mm, 12 point	135-160	100-120

** Bolts are specially heat-treated.*
DO NOT substitute with inferior grade bolts.

Table Q

Bearing retainers **CAN** be reused **if there is no damage**. (See photo 33, below.) If damaged, replace.

Photo 33, Bearing Retainers

Stamped straps **CANNOT** be reused. (See photo 34, below.) ▲ See warning, below.

Photo 34, Stamped Straps

▲ ***WARNING***

DO NOT *reuse bearing retainer bolts, stamped straps, stamped strap bolts, damaged bearing retainers, or use inferior grade bolts. Reuse of bearing retainer bolts, stamped straps, stamped strap bolts, damaged bearing retainers or the use of inferior grade bolts can cause driveline failure, which can result in separation of driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.*

Photo 35

4. It may be necessary to unseat bearing cup assemblies by tapping on yoke or bearing cup with a soft-faced hammer. (See photo 35, above.) Once the bearing cup assemblies are free, collapse the driveshaft until both bearing assemblies clear the open end yoke cross holes. Allow the driveshaft to rest on support strap.

Remove Driveshaft

5. **Place the second support strap as illustrated in Figure D, page 46.** Remove the bearing retainers or stamped straps and bolts at center bearing yoke position. Reference bolt specifications, Table Q, page 47. Discard bolts. Discard stamped straps (if applicable). ▲ See warning, below.

▲ ***WARNING***

DO NOT *reuse bearing retainer bolts, stamped straps, stamped strap bolts, damaged bearing retainers, or use inferior grade bolts. Reuse of bearing retainer bolts, stamped straps, stamped strap bolts, damaged bearing retainers or the use of inferior grade bolts can cause driveline failure, which can result in separation of driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.*

6. It may be necessary to unseat bearing cup assemblies by tapping on yoke or bearing cup with a soft-faced hammer. Once driveshaft is free, collapse the driveshaft until both bearing assemblies clear the open yoke cross holes. Allow the driveshaft to rest on support strap. Remove the driveshaft from the support straps and take it to a work bench area. ▲ See warning, below. Be sure to follow end yoke inspection (steps 10-13, page 49).

▲ ***WARNING***

Driveshaft assemblies can weigh in excess of 100 pounds (46 kilograms). Make sure to use proper lifting techniques when handling driveshafts. More than one person may be needed when handling driveshaft assemblies.

Remove Coupling Shaft

7. **Be sure the third support strap is in place, as illustrated in Figure D, page 46.** Remove the center bearing bracket bolts and allow the shaft to rest on the support strap. (See photo 36, below.)

Photo 36

8. **Be sure the fourth support strap is in place, as illustrated in Figure D, page 46.** Remove bearing retainers or stamped straps and bolts at front end. Reference bolt specifications Table Q, page 47. Discard bolts. Discard stamped straps (if applicable). ▲ See warning, below.

▲ ***WARNING***

DO NOT *reuse bearing retainer bolts, stamped straps, stamped strap bolts, damaged bearing retainers, or use inferior grade bolts. Reuse of bearing retainer bolts, stamped straps, stamped strap bolts, damaged bearing retainers or the use of inferior grade bolts can cause driveline failure, which can result in separation of driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.*

9. It may be necessary to unseat bearing cup assemblies by tapping on yoke or bearing cup with a soft-faced hammer. Once the coupling shaft is free, remove the coupling shaft from the support straps and take it to a work bench area. ▲ See warning, below. Be sure to follow end yoke inspection (steps 10-13).

▲ ***WARNING***

Driveshaft assemblies can weigh in excess of 100 pounds (46 kilograms). Make sure to use proper lifting techniques when handling driveshafts. More than one person may be needed when handling driveshaft assemblies.

Inspect End Yokes

10. Check all end yokes for looseness. Take hold of end yoke with both hands. Try to move it vertically and horizontally to feel any looseness. There should **not** be any looseness in the end yokes relative to the input or output shafts to which they are connected. ▲ See warning, below.

▲ ***WARNING***

A loose end yoke can result in driveline failure, which can result in separation of driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.

If looseness is evident, the end yoke needs to be replaced. Refer to the transmission, axle or transfer case original equipment manufacturers' service and maintenance manuals for removal procedures.

11. Visually inspect all end yoke retaining nuts or bolts for any gaps between mating surfaces. ▲ See warning, below.

▲ ***WARNING***

A loose end yoke retaining nut or bolt can result in driveline failure, which can result in separation of driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.

If gaps are present, consult transmission, axle or transfer case original equipment manufacturers' specifications for proper fastening.

12. Inspect all end yoke cross hole surfaces and bolt hole threads for damage. If the bolt hole threads are damaged, the yoke must be replaced. See warning, below.

WARNING

Failure to replace damaged driveline components can cause driveline failure, which can result in separation of driveline from vehicle. A separated driveline can result in property damage, serious personal injury or death.

Refer to the transmission, axle or transfer case original equipment manufacturers' service and maintenance manuals for removal procedures.

Photo 37

Raised metal or fretting on open yoke cross holes can be removed with a fine-toothed file and/or emery cloth. (See photo 37, above.) See warning, below.

WARNING

***DO NOT** deform yoke cross holes by removing excessive metal. Raised metal or deformed yoke cross holes can be a cause of cross and bearing failure, which can result in separation of driveline from vehicle. A separated driveline can result in property damage, serious personal injury or death.*

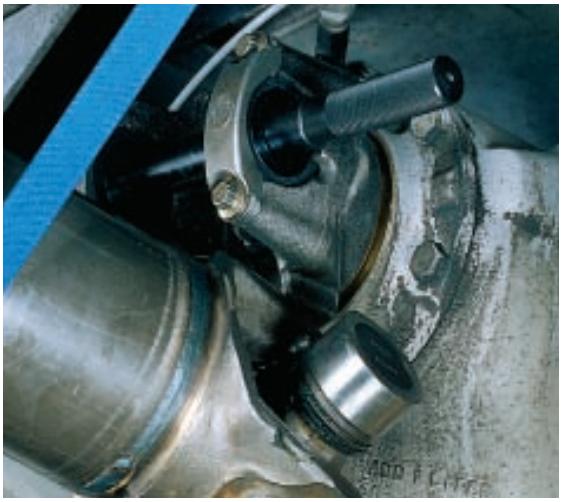


Photo 38

13. Inspect the end yoke cross holes for distortion using the appropriate Spicer alignment bar. (See photo 38, above.) Slide alignment bar through both cross holes simultaneously. If alignment bar will not pass through both cross holes simultaneously, cross holes are distorted and yoke must be replaced. See warning, below.

WARNING

Failure to replace damaged driveline components can cause driveline failure, which can result in separation of driveline from vehicle. A separated driveline can result in property damage, serious personal injury or death.

Refer to the transmission, axle or transfer case original equipment manufacturers' service and maintenance manuals for removal procedures.

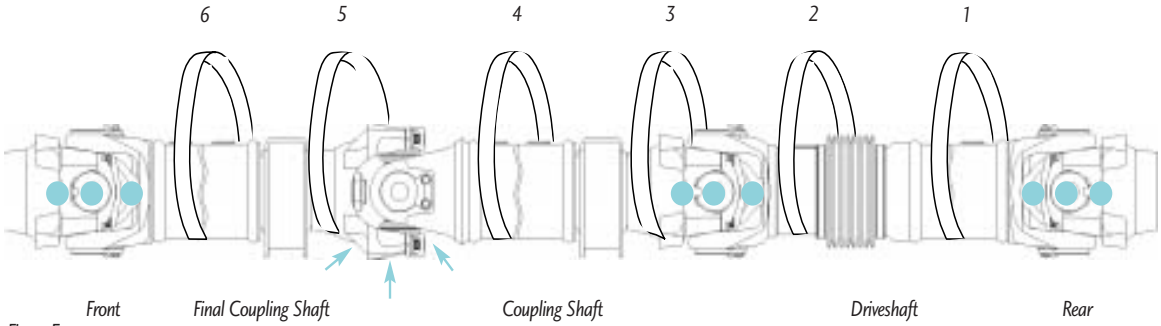


Figure E

QUICK DISCONNECT™ YOKE STYLE

Multiple-Piece Driveshaft

Caution – Be sure to carefully read all information on page 39 before proceeding.

Note – When working with multiple-piece driveshafts, it may be necessary to remove the entire driveline assembly. Work from the **rear** end forward. The driveshaft will need to be disconnected, **first**, in order to allow clearance for the removal of any coupling shaft. Work on only one connection at a time. Be sure to properly position the support straps as illustrated in Figure E, above.

Mark Driveshaft ("Phasing Marks")

1. It is imperative to mark all the mating components of a driveshaft, as illustrated in Figure E, above. Mark the driveshaft with a marking stick, paint marker or other legible marking device. In addition, be sure to mark all bearing positions, spline positions, shaft locations and all bearing retainers. This assures proper reassembly of the driveshaft into the vehicle, in its original position. ▲ See warning, below.

▲ ***WARNING***

Reassembly of a driveline out of original phase can cause vibration and failure of the driveline and attaching components. Failure of a driveline can result in separation of driveline from the vehicle, which can result in property damage, serious personal injury or death.

Position Support Straps

2. Working from the **rear** end, support the driveshaft at the rear, at the slip member, behind the center bearing end fittings and in front of center bearings, with support straps, as illustrated in Figure E, above. ▲ See warning, below.

▲ ***WARNING***

***ALWAYS** use support straps to prevent driveshaft from falling out of vehicle. Failure to use support straps can cause damage to driveshaft or result in property damage, serious personal injury or death.*

Attach support straps to frame rails or some structural part of the vehicle. **DO NOT** attach the support straps to fuel lines, oil lines, brake lines, or wiring. **DO NOT** entangle fuel lines, oil lines, brake lines, or wiring in the support straps. ▲ See warning, below.

▲ ***WARNING***

Attaching or entangling support straps to fuel, oil or brake lines or wiring can result in their damage. Damaged fuel, oil or brake lines or wiring can result in failure of the vehicle, which can result in property damage, serious personal injury or death.

Photo 39

Disconnect Driveshaft

3. **Be sure first support strap is in place as illustrated in Figure E, page 51.** Remove the bearing retainers or stamped straps and bolts at **rear** end. Discard bolts. Discard stamped straps (if applicable). (See photo 39, above.) Reference bolt specifications, Table R, below.

QUICK DISCONNECT™ BOLT SPECIFICATIONS

SERIES	BOLT P/N*	THREAD SIZE	HEAD SIZE	BOLT TORQUE Nm	BOLT TORQUE LB. FT.
SPL55	TBD	TBD	TBD	TBD	TBD
SPL70	TBD	TBD	TBD	TBD	TBD
SPL90	6-73-412	0.375 in. - 24	3/8 in., 12 point	61-81	45-60
SPL100	TBD	TBD	TBD	TBD	TBD
SPL140	12-73-125M	12mm - 1.25	12 mm, 12 point	135-160	100-120
SPL170	12-73-125M	12mm - 1.25	12 mm, 12 point	135-160	100-120
SPL250	12-73-125M	12mm - 1.25	12 mm, 12 point	135-160	100-120

** Bolts are specially heat-treated.*
DO NOT substitute with inferior grade bolts.

Table R

Bearing retainers **CAN** be reused **if there is no damage**. (See photo 40, below.) If damaged, replace.

Photo 40, Bearing Retainers

Stamped straps **CANNOT** be reused. Discard bolts. (See photo 41, below.) ▲ See warning, below.

Photo 41, Stamped Straps

▲ ***WARNING***

***DO NOT** reuse bearing retainer bolts, stamped straps, stamped strap bolts, damaged bearing retainers, or use inferior grade bolts. Reuse of bearing retainer bolts, stamped straps, stamped strap bolts, damaged bearing retainers or the use of inferior grade bolts can cause driveline failure, which can result in separation of driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.*

Photo 42

Photo 43

4. It may be necessary to unseat bearing cup assemblies by tapping on yoke or bearing cup with a soft-faced hammer. (See photo 42, above.) Once the bearing cup assemblies are free, collapse the driveshaft until both bearing assemblies clear the open yoke cross holes. Allow the driveshaft to rest on support strap.

Remove Driveshaft

5. **Be sure second support strap is in place as illustrated in Figure E, page 51**. Remove bearing retainers or stamped straps and bolts at the center bearing position yoke. Reference bolt specifications Table R, page 52. Discard bolts. Discard stamped straps (if applicable). ▲ See warning, below.

▲ ***WARNING***

DO NOT *reuse bearing retainer bolts, stamped straps, stamped strap bolts, damaged bearing retainers, or use inferior grade bolts. Reuse of bearing retainer bolts, stamped straps, stamped strap bolts, damaged bearing retainers or the use of inferior grade bolts can cause driveline failure, which can result in separation of driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.*

6. It may be necessary to unseat bearing cup assemblies by tapping on yoke or bearing cup with a soft-faced hammer. Once driveshaft is free, collapse the driveshaft until both bearing assemblies clear the open yoke cross holes. Allow the driveshaft to rest on support strap. Remove the driveshaft from the support straps and take it to a work bench area. ▲ See warning, below. Be sure to follow end yoke inspection (steps 13-16, page 55).

▲ ***WARNING***

Driveshaft assemblies can weigh in excess of 100 pounds (46 kilograms). Make sure to use proper lifting techniques when handling driveshafts. More than one person may be needed when handling driveshaft assemblies.

Remove Coupling Shaft(s)

7. **Position third support strap as illustrated in Figure E, page 51.** Remove the center bearing bracket bolts and allow the shaft to rest on the support strap.
(See photo 43, above.)

8. **Be sure the fourth support strap is in place as illustrated in Figure E, page 51.** Remove bearing retainers or stamped straps and bolts at next center bearing position yoke. Reference bolt torque specifications Table R, page 52. Discard bolts. Discard stamped straps (if applicable). ▲ See warning, below.

▲ ***WARNING***

DO NOT *reuse bearing retainer bolts, stamped straps, stamped strap bolts, damaged bearing retainers, or use inferior grade bolts. Reuse of bearing retainer bolts, stamped straps, stamped strap bolts, damaged bearing retainers or the use of inferior grade bolts can cause driveline failure, which can result in separation of driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.*

9. It may be necessary to unseat bearing cup assemblies by tapping on yoke or bearing cup with a soft-faced hammer. Once coupling shaft is free, remove from support straps and take to a workbench area. ▲ See warning, below. Be sure to follow the end yoke inspection (steps 13-16, page 55).

▲ ***WARNING***

Driveshaft assemblies can weigh in excess of 100 pounds (46 kilograms). Make sure to use proper lifting techniques when handling driveshafts. More than one person may be needed when handling driveshaft assemblies.

10. For driveline assemblies with more than two coupling shafts, repeat steps 7 through 9 as necessary. Place support straps on additional coupling shafts as previously described.

Removal of Final Coupling Shaft

11. **Be sure the final support strap is in place as illustrated in Figure E, page 51.** Remove bearing retainers or stamped straps and bolts at front end. Reference bolt specifications, Table R, page 52. Discard bolts. Discard stamped straps (if applicable). ▲ See warning, step 8.

12. It may be necessary to unseat bearing cup assemblies by tapping on yoke or bearing cup with a soft-faced hammer. Once final coupling shaft is free, remove from support straps and take it to a work bench area. ▲ See warning, below. Be sure to follow the end yoke inspection (steps 13-16, pages 55 and 56).

▲ ***WARNING***

Driveshaft assemblies can weigh in excess of 100 pounds (46 kilograms). Make sure to use proper lifting techniques when handling driveshafts. More than one person may be needed when handling driveshaft assemblies.

Inspect End Yokes

13. Check end yokes for looseness. Take hold of end yoke with both hands. Try to move it vertically and horizontally to feel any looseness. There should **NOT** be any looseness in the end yokes relative to the input or output shafts to which they are connected. ▲ See warning, below.

▲ ***WARNING***

A loose end yoke can result in driveline failure, which can result in separation of driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.

If looseness is evident, the end yoke needs to be replaced. Refer to the transmission, axle or transfer case original equipment manufacturers' service and maintenance manuals for removal procedures.

14. Visually inspect end yoke retaining nuts or bolts for any gaps between mating surfaces. ▲ See warning, below.

▲ ***WARNING***

A loose end yoke retaining nut or bolt can result in driveline failure, which can result in separation of driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.

If gaps are present, consult transmission, axle or transfer case original equipment manufacturers' specifications for proper fastening.

15. Inspect all end yoke cross hole surfaces and bolt hole threads for damage. If the bolt hole threads are damaged, the yoke must be replaced. ▲ See warning, below.

▲ ***WARNING***

Failure to replace damaged driveline components can cause driveline failure, which can result in separation of driveline from vehicle. A separated driveline can result in property damage, serious personal injury or death.

Refer to the transmission, axle or transfer case original equipment manufacturers' service and maintenance manuals for removal procedures.

Raised metal or fretting on open yoke cross holes can be removed with a fine-toothed file and/or emery cloth. (See photo 44, below.) ▲ See warning, below.

▲ ***WARNING***

DO NOT *deform yoke cross holes by removing excessive metal. Raised metal or deformed yoke cross holes can be a cause of cross and bearing failure, which can result in separation of driveline from vehicle. A separated driveline can result in property damage, serious personal injury or death.*

Photo 44

Photo 45

16. Inspect the end yoke cross holes for distortion using the appropriate Spicer alignment bar. (See photo 45, above.) Slide alignment bar through both cross holes simultaneously. If alignment bar will not pass through both cross holes simultaneously, cross holes are distorted and yoke must be replaced. ▲ See warning, below.

▲ ***WARNING***

Failure to replace damaged driveline components can cause driveline failure, which can result in separation of driveline from vehicle. A separated driveline can result in property damage, serious personal injury or death.

Refer to the transmission, axle or transfer case original equipment manufacturers' service and maintenance manuals for removal procedures.

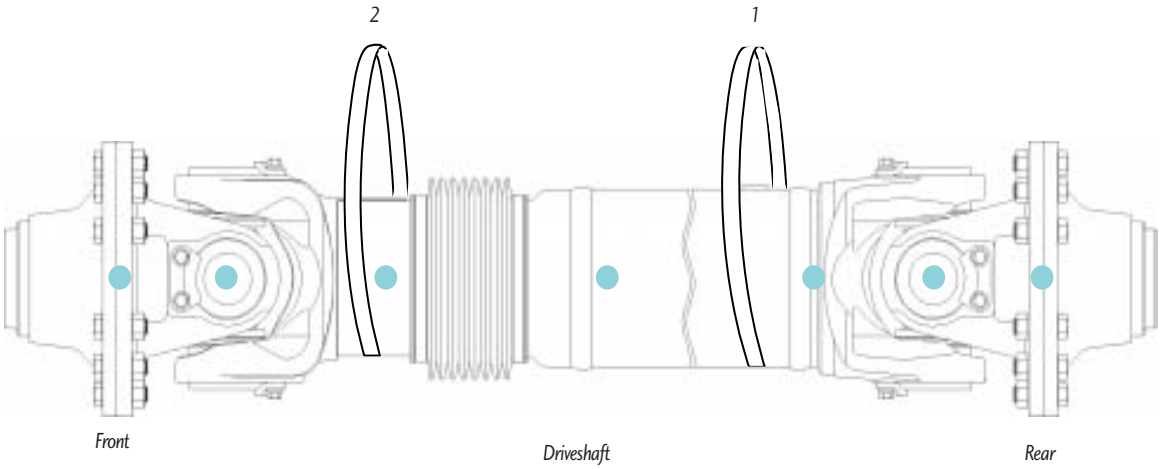


Figure F, S.A.E.

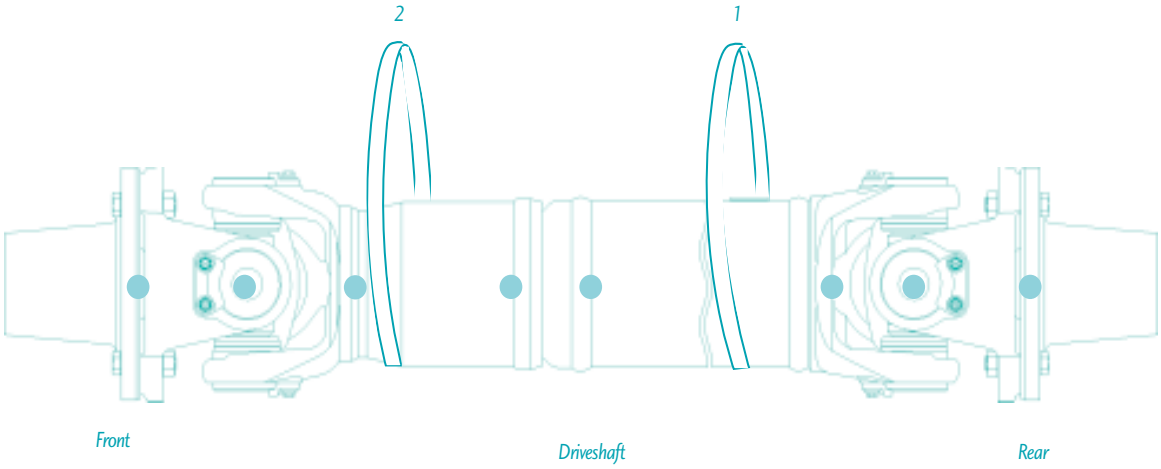


Figure G, DIN/T-Type

COMPANION FLANGE/FLANGE YOKE STYLE (S.A.E., DIN AND T-TYPE)

One-Piece Driveshaft

Caution – Be sure to carefully read all information on page 39 before proceeding.

Mark Driveshaft ("Phasing Marks")

1. It is imperative to mark all mating components of a driveshaft, as illustrated in Figure F or G, above. Mark the driveshaft with a marking stick, paint marker or other legible marking device. In addition, be sure to mark all bearing positions, spline positions, and shaft locations. This assures proper reassembly of the driveshaft into the vehicle, in its original position. ▲ See warning, below.

▲ ***WARNING***

Reassembly of a driveline out of original phase can cause vibration and failure of the driveline and attaching components. Failure of a driveline can result in separation of driveline from the vehicle, which can result in property damage, serious personal injury or death.

COMPANION FLANGE/FLANGE YOKE STYLE (S.A.E., DIN AND T-TYPE) HARDWARE SPECIFICATIONS

SERIES	BOLT P/N*†	WASHER P/N	NUT P/N	DIAMETER, THREAD & LENGTH UNDER HEAD	BOLT TORQUE Nm	BOLT TORQUE FT. LBS.
SPL55	TBD	TBD	TBD	TBD	TBD	TBD
SPL70	TBD	TBD	TBD	TBD	TBD	TBD
SPL90	6-73-1219	500357-11	231421-3	.375" 24 x 1.188"	54-65	40-48
SPL100	TBD	TBD	TBD	TBD	TBD	TBD
SPL140	6-73-220	500357-11	231421-3	.375" 24 x 1.250"	54-65	40-48
	6-73-1227	500357-11	231421-3	.375" 24 x 1.688"	54-65	40-48
SPL170	7-73-122	500357-12	231421-4	.438" 20 x 1.375"	85-102	63-75
	7-73-228	500357-12	231421-4	.438" 20 x 1.750"	85-102	63-75
SPL250	7-73-122	500357-12	231421-4	.438" 20 x 1.375"	85-102	63-75
	7-73-228	500357-12	231421-4	.438" 20 x 1.750"	85-102	63-75

**Bolts are specially heat-treated. DO NOT substitute inferior grade bolts.*

† Approved Spicer hardware.

***Note**-Original equipment vehicle manufacturers' manuals may have alternate specified bolts or metric hardware. Refer to the original equipment service manual for bolt part numbers.*

Table S

Position Support Straps

2. Working from the **rear** end, support the driveshaft with support straps, as illustrated in Figure F or G, page 57.

▲ See warning, below.

▲ ***WARNING***

***ALWAYS** use support straps to prevent driveshaft from falling out of vehicle. Failure to use support straps can cause damage to driveshaft or result in property damage, serious personal injury or death.*

Attach support straps to frame rails or some structural part of the vehicle. **DO NOT** attach the support straps to fuel lines, oil lines, brake lines, or wiring. **DO NOT** entangle fuel lines, oil lines, brake lines, or wiring in the support straps.

▲ See warning, below.

▲ ***WARNING***

Attaching or entangling support straps to fuel, oil or brake lines or wiring can result in their damage. Damaged fuel, oil or brake lines or wiring can result in failure of the vehicle, which can result in property damage, serious personal injury or death.

Disconnect Driveshaft

3. **Be sure first support strap is in place as illustrated in Figure F or G, page 57.** Remove and discard flange bolts, washers and nuts at **rear** end. Reference hardware specifications, Table S, above. (See photo 46, below.)

▲ See warning, below.

▲ ***WARNING***

***DO NOT** reuse flange bolts, washers or nuts or use inferior grade bolts. Reuse of flange bolts, washers or*

Photo 46

nuts or use of inferior grade bolts can cause driveline failure, which can result in separation of driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.

4. It may be necessary to unseat pilot or serrated connection by tapping on one side of flange with a soft-faced hammer. Once the connection is free, collapse the driveshaft and allow it to rest on support strap.

Remove Driveshaft

5. **Be sure to use the second support strap as illustrated in Figure F or G, page 57.** Remove and discard flange bolts, washers and nuts at **front** end. ▲ See warning, below.

▲ ***WARNING***

DO NOT *reuse flange bolts, washers or nuts or use inferior grade bolts. Reuse of flange bolts, washers or nuts or use of inferior grade bolts can cause driveline failure, which can result in separation of driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.*

6. It may be necessary to unseat pilot or serrated connection by tapping on one side of the flange with a soft-faced hammer. Once the connection is free, remove the driveshaft from the support straps and take it to a work bench area. ▲ See warning, below. Be sure to follow the flange inspection (steps 7-10).

▲ ***WARNING***

Driveshaft assemblies can weigh in excess of 100 pounds (46 kilograms). Make sure to use proper lifting techniques when handling driveshafts. More than one person may be needed when handling driveshaft assemblies.

Inspect Companion Flanges/Flange Yokes (S.A.E., DIN and T-Type Style)

7. Inspect all flange bolt hole threads or through holes for damage. If the bolt hole threads or through holes are damaged, the flange must be replaced. ▲ See warning, below.

▲ ***WARNING***

Failure to replace damaged driveline components can cause driveline failure, which can result in separation of driveline from vehicle. A separated driveline can result in property damage, serious personal injury or death.

For removal procedures for companion flanges, refer to the original equipment manufacturers' service and maintenance manuals. For removal procedures for flange yokes, see removal of universal joints in this manual.

8. Inspect all flange faces for galling or damage. If damaged, the flange must be replaced. ▲ See warning, above.

For removal procedures for companion flanges, refer to the original equipment manufacturers' service and maintenance manuals. For removal procedures for flange yokes, see removal of universal joints in this manual.

9. Visually inspect all companion flange retaining nuts or bolts for any gaps between mating surfaces. See warning, below.

WARNING

A loose companion flange retaining nut or bolt can result in driveline failure which can result in separation of driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.

If gaps are present, consult transmission, axle or transfer case original equipment manufacturers' specifications for proper fastening.

10. Check all companion flanges for looseness. Take hold of companion flange with both hands. Try to move it vertically and horizontally to feel any looseness. There should **NOT** be any looseness in the companion flanges relative to the input or output shafts to which they are connected. See warning, below.

WARNING

A loose companion flange can result in driveline failure, which can result in separation of driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.

If looseness is evident, the companion flange needs to be replaced. Refer to the transmission, axle or transfer case original equipment manufacturers' service and maintenance manuals for removal procedures.

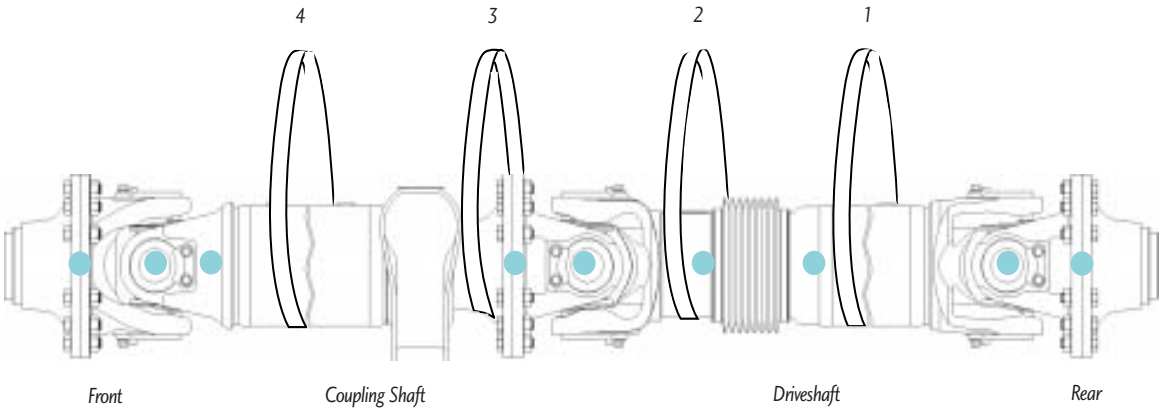


Figure H, S.A.E.

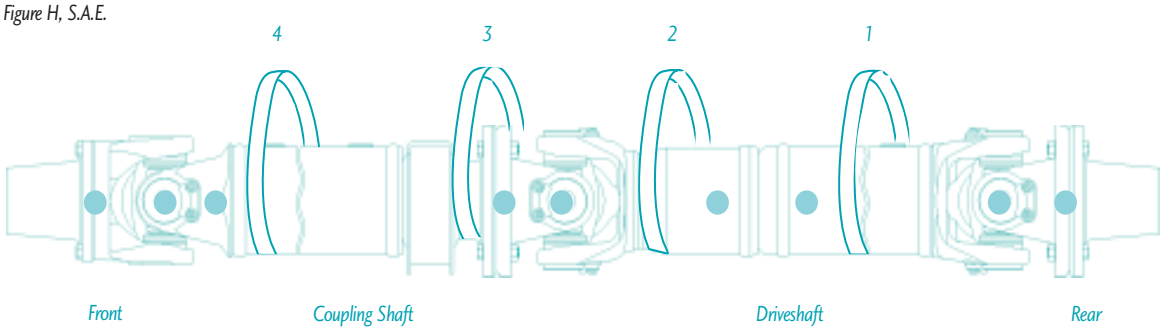


Figure J, DIN/T-Type

COMPANION FLANGE/FLANGE YOKE STYLE (S.A.E., DIN AND T-TYPE)

Two-Piece Driveshaft

Caution – Be sure to carefully read all information on page 39 before proceeding.

Mark Driveshaft ("Phasing Marks")

1. It is imperative to mark all the mating components of a driveshaft, as illustrated in Figure H or J, above. Mark the driveshaft with a marking stick, paint marker or other legible marking device. In addition, be sure to mark all bearing positions, spline positions, and shaft locations. This assures proper reassembly of the driveshaft into the vehicle, in its original position. ▲ See warning, above right.

▲ ***WARNING***

Reassembly of a driveline out of original phase can cause vibration and failure of the driveline and attaching components. Failure of a driveline can result in separation of driveline from the vehicle, which can result in property damage, serious personal injury or death.

Position Support Straps

2. Working from the **rear** end, support the driveshaft with support straps as illustrated in Figure H or J, above. Be sure to support the shaft assembly at the slip member, behind the center bearing end fitting and in front of center bearing, with support straps. ▲ See warning, below.

▲ ***WARNING***

***ALWAYS** use support straps to prevent driveshaft from falling out of vehicle. Failure to use support straps can cause damage to driveshaft or result in property damage, serious personal injury or death.*

COMPANION FLANGE/FLANGE YOKE STYLE (S.A.E., DIN AND T-TYPE) HARDWARE SPECIFICATIONS

SERIES	BOLT P/N*†	WASHER P/N	NUT P/N	DIAMETER, THREAD & LENGTH UNDER HEAD	BOLT TORQUE Nm	BOLT TORQUE FT. LBS.
SPL55	TBD	TBD	TBD	TBD	TBD	TBD
SPL70	TBD	TBD	TBD	TBD	TBD	TBD
SPL90	6-73-1219	500357-11	231421-3	.375" 24 x 1.188"	54-65	40-48
SPL100	TBD	TBD	TBD	TBD	TBD	TBD
SPL140	6-73-220	500357-11	231421-3	.375" 24 x 1.250"	54-65	40-48
	6-73-1227	500357-11	231421-3	.375" 24 x 1.688"	54-65	40-48
SPL170	7-73-122	500357-12	231421-4	.438" 20 x 1.375"	85-102	63-75
	7-73-228	500357-12	231421-4	.438" 20 x 1.750"	85-102	63-75
SPL250	7-73-122	500357-12	231421-4	.438" 20 x 1.375"	85-102	63-75
	7-73-228	500357-12	231421-4	.438" 20 x 1.750"	85-102	63-75

**Bolts are specially heat-treated. DO NOT substitute inferior grade bolts.*
† Approved Spicer hardware.
***Note**-Original equipment vehicle manufacturers' manuals may have alternate specified bolts or metric hardware. Refer to the original equipment service manual for bolt part numbers.*

Table T

Attach support straps to frame rails or some structural part of the vehicle. **DO NOT** attach the support straps to fuel lines, oil lines, brake lines, or wiring. **DO NOT** entangle fuel lines, oil lines, brake lines, or wiring in the support straps. ▲ See warning, below.

▲ *WARNING*

Attaching or entangling support straps to fuel, oil or brake lines or wiring can result in their damage. Damaged fuel, oil or brake lines or wiring can result in failure of the vehicle, which can result in property damage, serious personal injury or death.

Photo 47

Disconnect Driveshaft

3. **Be sure first support strap is in place as illustrated in Figures H or J, page 61.** Remove and discard flange bolts, washers and nuts at **front** end. (See photo 47, right.) Reference hardware specifications, Table T, above. ▲ See warning, below.

▲ *WARNING*

***DO NOT** reuse flange bolts, washers or nuts or use inferior grade bolts. Reuse of flange bolts, washers or nuts or use of inferior grade bolts can cause driveline failure, which can result in separation of driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.*

4. It may be necessary to unseat pilot or serrated connection by tapping on one side of flange with a soft-faced hammer. Once the connection is free, collapse the driveshaft and allow it to rest on support strap.

Remove Driveshaft

5. **Place the second support strap as illustrated in Figure H or J, page 61.** Remove and discard flange bolts, washers and nuts at center bearing end fitting position. Reference hardware specifications, Table T, page 62. ▲ See warning, below.

▲ ***WARNING***

DO NOT *reuse flange bolts, washers or nuts or use inferior grade bolts. Reuse of flange bolts, washers or nuts or use of inferior grade bolts can cause driveline failure, which can result in separation of driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.*

6. It may be necessary to unseat pilot or serrated connection by tapping on one side of flange with a soft-faced hammer. Once the connection is free, remove the driveshaft from the support straps and take it to a work bench area. ▲ See warning, below. Be sure to follow the flange inspection (steps 10-13).

▲ ***WARNING***

Driveshaft assemblies can weigh in excess of 100 pounds (46 kilograms). Make sure to use proper lifting techniques when handling driveshafts. More than one person may be needed when handling driveshaft assemblies.

Remove Coupling Shaft

7. **Be sure the third support strap is in place as illustrated in Figures H or J, page 61.** Remove the center bearing bracket bolts and allow shaft to rest on support strap.

8. **Be sure the fourth support strap is in place as illustrated in Figures H or J, page 61.** Remove and discard flange bolts, washers and nuts at **front** end. Reference hardware specifications, Table T, page 62. ▲ See warning, step 5.

9. It may be necessary to unseat pilot or serrated connection by tapping on one side of flange with a soft-faced hammer. Once the connection is free, remove the coupling shaft from the support straps and take it to a work bench area. ▲ See warning, step 6. Be sure to follow the flange inspection (steps 10-13).

Inspect Companion Flanges/Flange Yokes (S.A.E., DIN and T-Type Style)

10. Inspect all flange bolt hole threads or through holes for damage. If the bolt hole threads or through holes are damaged, the flange must be replaced. ▲ See warning, below.

▲ ***WARNING***

Failure to replace damaged driveline components can cause driveline failure, which can result in separation of driveline from vehicle. A separated driveline can result in property damage, serious personal injury or death.

For removal procedures for companion flanges, refer to the equipment manufacturers' service and maintenance manuals. For removal procedures for flange yokes, see removal of universal joints in this manual.

11. Inspect all flange faces for galling or damage. If damaged, the flange must be replaced. ▲ See warning, step 10.

For removal procedures for companion flanges, refer to the equipment manufacturers' service and maintenance manuals. For removal procedures for flange yokes, see removal of universal joints in this manual.

12. Visually inspect all companion flange retaining nuts or bolts for any gaps between mating surfaces. See warning, below.

WARNING

A loose companion flange retaining nut or bolt can result in driveline failure, which can result in separation of driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.

If gaps are present, consult transmission, axle or transfer case original equipment manufacturers' specifications for proper fastening.

13. Check all companion flanges for looseness. Take hold of companion flange with both hands. Try to move it vertically and horizontally to feel any looseness. There should **NOT** be any looseness in the companion flanges relative to the input or output shafts to which they are connected. See warning, below.

WARNING

A loose companion flange can result in driveline failure, which can result in separation of driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.

If looseness is evident, the companion flange needs to be replaced. Refer to the transmission, axle or transfer case original equipment manufacturers' service and maintenance manuals for removal procedures.

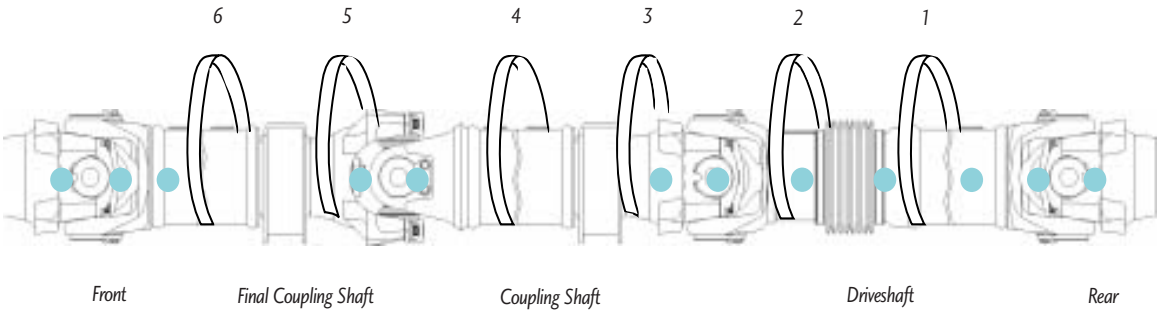


Figure K, S.A.E.

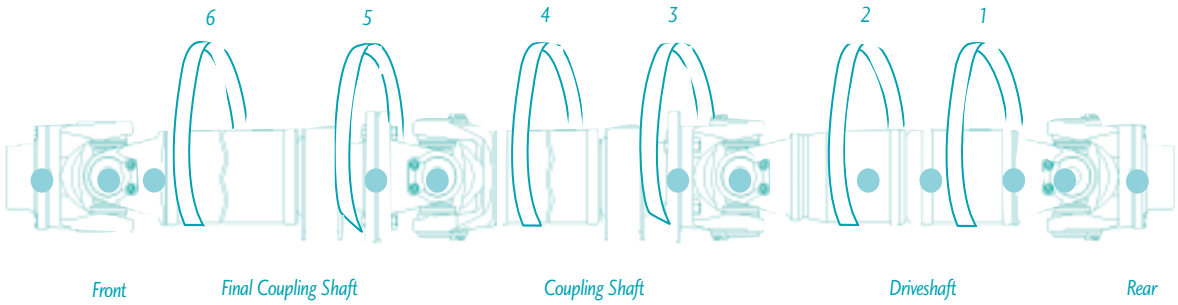


Figure L, DIN/T-Type

COMPANION FLANGE/FLANGE YOKE STYLE (S.A.E., DIN AND T-TYPE)

Multiple-Piece Driveshaft

Caution – Be sure to carefully read all information on page 39 before proceeding.

Note – When working with multiple-piece driveshafts, it may be necessary to remove the entire assembly. Work from **rear** end forward. The driveshaft will need to be disconnected **first** in order to allow clearance for the removal of any coupling shaft. Work on only one connection at a time. Be sure to properly position the support straps as illustrated in Figure K or L, above.

Mark Driveshaft ("Phasing Marks")

1. It is imperative to mark all mating components of a driveshaft, as illustrated in Figure K or L, above. Mark the driveshaft with a marking stick, paint marker or other legible marking device. In addition, be sure to mark all bearing positions, spline positions, and shaft locations. This assures proper reassembly of the driveshaft into the vehicle, in its original position. ▲ See warning, below.

▲ ***WARNING***

Reassembly of a driveline out of original phase can cause vibration and failure of the driveline and attaching components. Failure of a driveline can result in separation of driveline from the vehicle which can result in property damage, serious personal injury or death.

COMPANION FLANGE/FLANGE YOKE STYLE (S.A.E., DIN AND T-TYPE) HARDWARE SPECIFICATIONS

SERIES	BOLT P/N*†	WASHER P/N	NUT P/N	DIAMETER, THREAD & LENGTH UNDER HEAD	BOLT TORQUE Nm	BOLT TORQUE FT. LBS.
SPL55	TBD	TBD	TBD	TBD	TBD	TBD
SPL70	TBD	TBD	TBD	TBD	TBD	TBD
SPL90	6-73-1219	500357-11	231421-3	.375" 24 x 1.188"	54-65	40-48
SPL100	TBD	TBD	TBD	TBD	TBD	TBD
SPL140	6-73-220	500357-11	231421-3	.375" 24 x 1.250"	54-65	40-48
	6-73-1227	500357-11	231421-3	.375" 24 x 1.688"	54-65	40-48
SPL170	7-73-122	500357-12	231421-4	.438" 20 x 1.375"	85-102	63-75
	7-73-228	500357-12	231421-4	.438" 20 x 1.750"	85-102	63-75
SPL250	7-73-122	500357-12	231421-4	.438" 20 x 1.375"	85-102	63-75
	7-73-228	500357-12	231421-4	.438" 20 x 1.750"	85-102	63-75

**Bolts are specially heat-treated. DO NOT substitute inferior grade bolts.*

† Approved Spicer hardware.

***Note**-Original equipment vehicle manufacturers' manuals may have alternate specified bolts or metric hardware. Refer to the original equipment service manual for bolt part numbers.*

Table U

Position Support Straps

2. Working from the **rear** end forward, support the driveshaft with support straps as illustrated in Figure K or L, page 65. Be sure to support the shaft assembly at the slip member, behind the center bearing end fitting, and in front of center bearing, with support straps.

See warning, below.

WARNING

***ALWAYS** use support straps to prevent driveshaft from falling out of vehicle. Failure to use support straps can cause damage to driveshaft or result in property damage, serious personal injury or death.*

Attach support straps to frame rails or some structural part of the vehicle. **DO NOT** attach the support straps to fuel lines, oil lines, brake lines, or wiring. **DO NOT** entangle fuel lines, oil lines, brake lines, or wiring in the support straps. See warning, above right.

WARNING

Attaching or entangling support straps to fuel, oil or brake lines or wiring can result in their damage. Damaged fuel, oil or brake lines or wiring can result in failure of the vehicle, which can result in property damage, serious personal injury or death.

Disconnect Driveshaft

3. **Be sure the first support strap is in place as illustrated in Figure K or L, page 65.** Remove and discard flange bolts, washers and nuts at **rear** end. (See photo 48, page 67.) Reference hardware specifications, Table U, above.

See warning, below.

WARNING

***DO NOT** reuse flange bolts, washers or nuts or use inferior grade bolts. Reuse of flange bolts, washers or nuts or use of inferior grade bolts can cause driveline failure, which can result in separation of driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.*

Photo 48

4. It may be necessary to unseat pilot or serrated connection by tapping on one side of flange with a soft-faced hammer. Once the connection is free, collapse the driveshaft and allow it to rest on support strap.

Remove Driveshaft

5. **Place the second support strap as illustrated in Figure K or L, page 65.** Remove and discard flange bolts, washers and nuts at center bearing end fitting position. Reference hardware specifications, Table U, page 66. ▲ See warning, below.

▲ ***WARNING***

DO NOT *reuse flange bolts, washers or nuts or use inferior grade bolts. Reuse of flange bolts, washers or nuts or use of inferior grade bolts can cause driveline failure, which can result in separation of driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.*

6. It may be necessary to unseat pilot or serrated connection by tapping on one side of flange with a soft-faced hammer. Once the connection is free, remove the driveshaft from the support straps and take it to a work bench area. ▲ See warning, above right. Be sure to follow the flange inspection (steps 13-16, pages 68-69).

▲ ***WARNING***

Driveshaft assemblies can weigh in excess of 100 pounds (46 kilograms). Make sure to use proper lifting techniques when handling driveshafts. More than one person may be needed when handling driveshaft assemblies.

Remove Coupling Shaft(s)

7. **Be sure the third support strap is in place as illustrated in Figures K or L, page 65.** Remove the center bearing bracket bolts and allow shaft to rest on support strap.

8. **Be sure the fourth support strap is in place as illustrated in Figures K or L, page 65.** Remove and discard flange bolts, washers and nuts at next center bearing end fitting. Reference hardware specifications, Table U, page 66. ▲ See warning, step 5.

9. It may be necessary to unseat pilot or serrated connection by tapping on one side of flange with a soft-faced hammer. Once the connection is free, remove the coupling shaft from the support straps and take it to a work bench area. ▲ See warning, step 6. Be sure to follow the flange inspection (steps 13-16, pages 68-69).

10. For driveline assemblies with more than two coupling shafts, repeat steps 7 through 9 as necessary. Place support straps on additional coupling shafts as previously described.

Removal of Final Coupling Shaft

11. **Be sure the final support strap is in place as illustrated in Figures K or L, page 65.** Remove flange bolts, washers and nuts at front end. Reference hardware specifications Table U, page 66. See warning, below.

WARNING

Do not reuse flange bolts, washers or nuts or use inferior grade bolts. Reuse of flange bolts, washers or nuts or use of inferior grade bolts can cause driveline failure, which can result in separation of driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.

12. It may be necessary to unseat pilot or serrated connection by tapping on one side of flange with a soft-faced hammer. Once the connection is free, remove the final coupling shaft from the support straps and take it to a work bench area. See warning, below. Be sure to follow the flange inspection (steps 13-16).

WARNING

Driveshaft assemblies can weigh in excess of 100 pounds (46 kilograms). Make sure to use proper lifting techniques when handling driveshafts. More than one person may be needed when handling driveshaft assemblies.

Inspect Companion Flanges/Flange Yokes (S.A.E., DIN and T-Type Style)

13. Inspect all flange bolt hole threads or through holes for damage. If the bolt hole threads or through holes are damaged, the flange must be replaced.

See warning, below.

WARNING

Failure to replace damaged driveline components can cause driveline failure, which can result in separation of driveline from vehicle. A separated driveline can result in property damage, serious personal injury or death.

For the removal of companion flanges, refer to the equipment manufacturers' service and maintenance manuals. For the removal of the flange yokes, see removal of universal joints in this manual.

14. Inspect all flange faces for galling or damage. If damaged, the flange must be replaced. See warning, above.

For the removal of companion flanges, refer to the equipment manufacturers' service and maintenance manuals. For the removal of the flange yokes, see removal of universal joints in this manual.

15. Visually inspect all companion flange retaining nuts or bolts for any gaps between mating surfaces. ▲ See warning, below.

▲ ***WARNING***

A loose companion flange retaining nut or bolt can result in driveline failure, which can result in separation of driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.

If gaps are present, consult transmission, axle or transfer case original equipment manufacturers' specifications for proper fastening.

16. Check all companion flanges for looseness. Take hold of companion flange with both hands. Try to move it vertically and horizontally to feel any looseness. There should **NOT** be any looseness in the companion flanges relative to the input or output shafts to which they are connected. ▲ See warning, below.

▲ ***WARNING***

A loose companion flange can result in driveline failure, which can result in separation of driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.

If looseness is evident, the companion flange needs to be replaced. Refer to the transmission, axle or transfer case original equipment manufacturers' service and maintenance manuals for removal procedures.

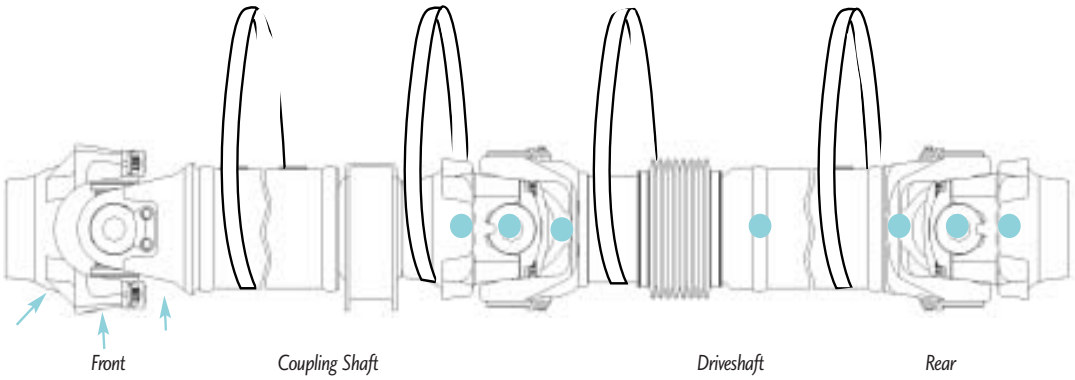


Figure M

REPLACEMENT PROCEDURE FOR GREASE ZERK (NIPPLE) FITTINGS OR PLUGS

SPICER LIFE SERIES™ 90,100,140,170 & 250

Caution – Be sure to carefully read all information on page 39 before proceeding.

Required Tools

- Open-ended wrench or pliers

UNIVERSAL JOINTS

Note – When working with multiple-piece driveshafts, it may be necessary to remove the entire assembly. Work from **rear** end forward. The driveshaft will need to be disconnected to allow clearance for the disconnection of any coupling shaft. Work on only one connection at a time. Be sure to properly position the support straps.

Follow removal procedures for the appropriate style driveshaft being serviced. (See page listings at right.) Follow steps until reaching effected universal joint grease zerk (nipple) fitting or plug. Then proceed to step one in this section.

Quick Disconnect Style

Companion Flange/Flange Yoke Style

Remove Effected Grease Zerk (Nipple) Fitting or Plug

1. Tilt the universal joint kit or flange yoke and universal joint kit to allow access to effected grease zerk (nipple) fitting or plug. Using pliers or an open-ended wrench, turn grease zerk (nipple) fitting or plug counter-clockwise, until it is removed from the journal cross. (See photo 49, below.) Discard the grease zerk (nipple) fitting or plug.

Photo 49

Grease Zerk (Nipple) Fitting Only

Check for threads in the journal. If threads are present, proceed to next step. If threads are not present, replacement of universal joint kit is necessary. See disassembly procedure for universal joint kits:

- Spring Tab Style, pages 73 to 81.
- Snap Ring Style, pages 82 to 88.

Note – Pressed-in style grease zerk fittings are **NOT** serviceable. Replacement of universal joint kit is required. Press-in grease zerk (nipple) fittings were discontinued in August, 1997.

2. Thoroughly wipe clean the grease zerk (nipple) fitting or plug threaded hole.

Install New Grease Zerk (Nipple) Fitting or Plug

3. Install new grease zerk (nipple) fitting (Spicer part number 232830) or plug. Tighten to minimum 15 ft. lbs. (20 Nm). Then continue to turn only until grease zerk (nipple) fitting is correctly positioned. (See photo 49 for correct grease zerk (nipple) fitting position.) ▲ See warning, below.

▲ ***WARNING***

*Hand tightening of grease zerk (nipple) fittings or plugs is **NOT** recommended. Grease zerk (nipple) fittings or plug will eventually vibrate loose and fall out of journal. Prolonged operation with missing grease zerk (nipple) fittings or plug allows contaminants into the universal joint. Invasion of contaminants into the universal joint can degrade the lubricant and cause universal joint damage, which can result in separation of the driveline from the vehicle. A separated driveline can cause property damage, serious personal injury or death.*

Reconnect Driveshaft or Coupling Shaft

Follow installation procedures for the appropriate style driveshaft being serviced. (See page listings, top right.)

Note – Be sure to completely lubricate the universal joint kit following lubrication procedures on page 25.

Quick Disconnect Style

Companion Flange/Flange Yoke Style

SLIP MEMBER ASSEMBLY SPICER LIFE SERIES™ 90

Remove Effected Grease Zerk (Nipple) Fitting

1. Using pliers or an open-ended wrench, turn grease zerk (nipple) fitting counter-clockwise, until it is removed from the slip yoke seal. Discard the grease zerk (nipple) fitting.

2. Thoroughly wipe clean the grease zerk (nipple) fitting threaded hole.

Install New Grease Zerk (Nipple) Fitting

3. Install new grease zerk (nipple) fitting (Spicer part number 500174-1). Tighten to 31-55 in. lbs. (3.5-6.2 Nm). ▲ See warning, below.

▲ ***WARNING***

*Hand tightening of slip member grease zerk (nipple) fittings is **NOT** recommended. Grease zerk (nipple) fittings will eventually vibrate loose and fall out of slip member. Prolonged operation with missing grease zerk (nipple) fittings allows contaminants into the slip member. Invasion of contaminants into the slip member can degrade the lubricant and cause slip member damage, which can result in separation of the driveline from the vehicle. A separated driveline can cause property damage, serious personal injury or death.*

REMOVAL PROCEDURE FOR UNIVERSAL JOINT KITS

SPICER LIFE SERIES™ 55, 70, 90, 100, 140, 170 & 250

Required Tools

- Support Straps
- Ratchet or Air Gun
- Appropriate Spicer Alignment Bar
  (See photo 50 or 51, right.)

Spicer Life Series™ 140, 170 & 250

- 12-Point Sockets
  English 3/8"
  Metric 12mm
- 6-Point, 8mm Socket

Spicer Life Series™ 55, 70, 90 &100

- Pliers for Snap Rings

One of the following is recommended:

- Three-ton (minimum) Arbor Press
  (for Spicer Life Series™ 55, 70, 90, 100, 140, 170 & 250) and
  Bearing Cup Spacer, and
  Push Rod
  or
- J & J Universal Joint Puller 4LIFE (see photo 52, right)
  (for Spicer Life Series™ 140, 170 & 250)
  1-800-221-4903
  Outside U.S. and Canada 215-256-9300
  or
- Tiger Tool MARK 1A (see photo 53, right)
  or TGLS-597 (not shown)
  (for Spicer Life Series™ 140, 170 & 250)
  1-800-661-4661
  Outside U.S. and Canada 604-855-1133

Photo 50, Spicer Alignment Bar Kit Quick Disconnect Style

Photo 51, Spicer Alignment Bar, Full Round Style

Photo 52

Photo 53

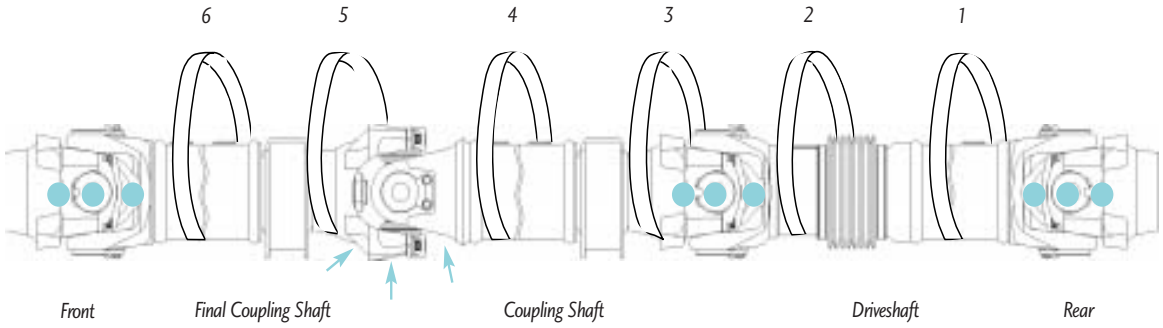


Figure N Quick Disconnect

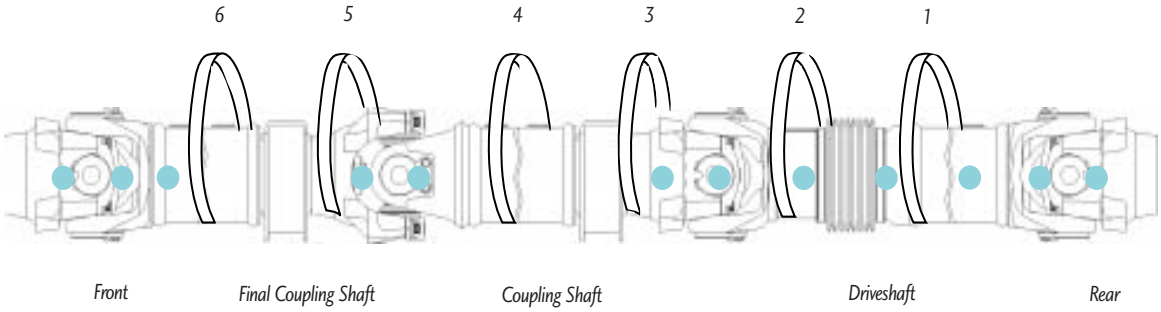


Figure P, S.A.E.

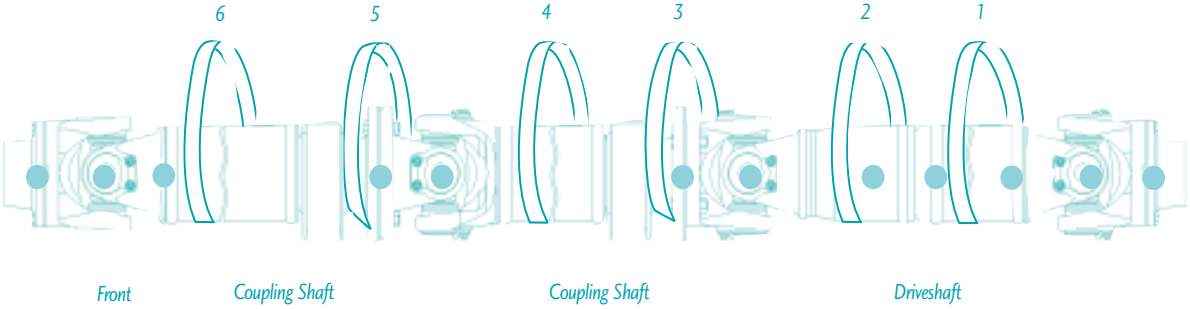


Figure Q, DIN/T-Type

SPRING TAB STYLE SPICER LIFE SERIES™ 140, 170 & 250

Caution – Be sure to carefully read all information on page 39 before proceeding.

Note – When working with multiple-piece driveshafts, it may be necessary to remove the entire driveline assembly to reach the effected universal joint. Work from the rear end forward. The driveshaft will need to be disconnected to allow clearance for the removal of any coupling shaft. Work on only one connection at a time. Be sure to properly position support straps.

Note – For more detailed driveshaft assembly removal procedures, see removal procedure for driveshaft assemblies in table of contents.

Mark Driveshaft ("Phasing Marks")

1. It is imperative to mark all mating components of the driveshaft or coupling shaft with the effected universal joint(s). Mark the driveshaft or coupling shaft with a marking stick, paint marker or other legible marking device. In addition, be sure to mark bearing positions. This assures

proper reassembly of the driveshaft or coupling shaft into the vehicle, in its original position. ▲ See warning, below.

▲ ***WARNING***

Reassembly of a driveline out of original phase can cause vibration and failure of the driveline and attaching components. Failure of a driveline can result in separation of driveline from the vehicle, which can result in property damage, serious personal injury or death.

Position Support Straps

2. Working on the driveshaft assembly section with the effected universal joint(s), place support straps as illustrated in Figure N, P or Q, page 73, for the appropriate style driveshaft being serviced.

Driveshaft

Be sure to position support straps 1 and 2. ▲ See warning, below.

Coupling Shaft(s)

Be sure to position support straps 2, 3 and 4. ▲ See warning, below.

Final Position Coupling Shaft

Be sure to position support straps 4, 5 and 6. ▲ See warning, below.

▲ ***WARNING***

***ALWAYS** use support straps to prevent driveshaft from falling out of vehicle. Failure to use support straps can cause damage to driveshaft or result in property damage, serious personal injury or death.*

Attach support straps to frame rails or some structural part of the vehicle. **DO NOT** attach the support straps to fuel lines, oil lines, brake lines, or wiring. **DO NOT** entangle fuel lines, oil lines, brake lines, or wiring in the support straps. ▲ See warning, below.

▲ ***WARNING***

Attaching or entangling support straps to fuel, oil or brake lines or wiring can result in their damage. Damaged fuel, oil or brake lines or wiring can result in failure of the vehicle, which can result in property damage, serious personal injury or death.

For removal of a **driveshaft** with an effected universal joint, follow steps 3-6.

For removal of **coupling shaft(s)** with an effected universal joint, follow steps 3-11.

For removal of the **final position coupling shaft** with an effected universal joint, follow steps 3-15.

Disconnect Driveshaft

3. Remove bearing retainers and bolts or companion flange bolts, washers and nuts at the effected universal joint. Reference bolt specifications Table V, below, or hardware specifications Table W, page 75.

QUICK DISCONNECT™ BOLT SPECIFICATIONS

SERIES	BOLT P/N*	THREAD SIZE	HEAD SIZE	BOLT TORQUE Nm	BOLT TORQUE LB. FT.
SPL55	TBD	TBD	TBD	TBD	TBD
SPL70	TBD	TBD	TBD	TBD	TBD
SPL90	6-73-412	0.375 in. - 24	3/8 in., 12 point	61-81	45-60
SPL100	TBD	TBD	TBD	TBD	TBD
SPL140	12-73-125M	12mm - 1.25	12 mm, 12 point	135-160	100-120
SPL170	12-73-125M	12mm - 1.25	12 mm, 12 point	135-160	100-120
SPL250	12-73-125M	12mm - 1.25	12 mm, 12 point	135-160	100-120

** Bolts are specially heat-treated.*
DO NOT substitute with inferior grade bolts.

Table V

COMPANION FLANGE/FLANGE YOKE STYLE (S.A.E., DIN AND T-TYPE) HARDWARE SPECIFICATIONS

SERIES	BOLT P/N*†	WASHER P/N	NUT P/N	DIAMETER, THREAD & LENGTH UNDER HEAD	BOLT TORQUE Nm	BOLT TORQUE FT. LBS.
SPL55	TBD	TBD	TBD	TBD	TBD	TBD
SPL70	TBD	TBD	TBD	TBD	TBD	TBD
SPL90	6-73-1219	500357-11	231421-3	.375" 24 x 1.188"	54-65	40-48
SPL100	TBD	TBD	TBD	TBD	TBD	TBD
SPL140	6-73-220	500357-11	231421-3	.375" 24 x 1.250"	54-65	40-48
	6-73-1227	500357-11	231421-3	.375" 24 x 1.688"	54-65	40-48
SPL170	7-73-122	500357-12	231421-4	.438" 20 x 1.375"	85-102	63-75
	7-73-228	500357-12	231421-4	.438" 20 x 1.750"	85-102	63-75
SPL250	7-73-122	500357-12	231421-4	.438" 20 x 1.375"	85-102	63-75
	7-73-228	500357-12	231421-4	.438" 20 x 1.750"	85-102	63-75

**Bolts are specially heat-treated. DO NOT substitute inferior grade bolts.*
† Approved Spicer hardware.
***Note**-Original equipment vehicle manufacturers' manuals may have alternate specified bolts or metric hardware. Refer to the original equipment service manual for bolt part numbers.*

Table W

Bearing retainers **CAN** be reused **if there is no damage**. (See photo 54, below.) If damaged, replace with new. ▲ See warning, below.

Photo 54, Bearing Retainers

Bearing retainer bolts or companion flange bolts, washers and nuts **CANNOT** be reused. Discard bolts and/or hardware, replace with new. ▲ See warning, below.

▲ *WARNING*

***DO NOT** reuse bearing retainer bolts, damaged bearing retainers, companion flange bolts, washers or nuts or use inferior grade bolts. Reuse of bearing retainer bolts, damaged bearing retainers, companion flange bolts, washers or nuts or the use of inferior grade bolts can cause driveline failure, which can result in separation of driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.*

4. It may be necessary to unseat bearing cup assemblies, pilot or serrated connection by tapping on tube yoke or bearing cup with a soft-faced hammer. (See photo 55, below.) Once the bearing cup assemblies or connections are free, collapse the driveshaft until both bearing cup assemblies clear the open cross holes or flange yoke pilot is disconnected. Allow the driveshaft to rest on support strap.

Photo 55

Remove Driveshaft

5. **Be sure the second support strap is in place as illustrated in Figure N, P or Q, page 73.** Remove bearing retainers and bolts or companion flange bolts, washers and nuts at the opposite end of the driveshaft. Reference bolt specifications, Table V, page 74, or hardware specifications, Table W, page 75. Discard bearing retainer bolts or companion flange bolts, washers and nuts.

Bearing retainers **CAN** be reused **if there is no damage**. If damaged, replace with new. ▲ See warning, below.

Bearing retainer bolts or companion flange bolts, washers and nuts **CANNOT** be reused. Discard bolts and/or hardware replace with new. ▲ See warning, below.

▲ ***WARNING***

DO NOT *reuse bearing retainer bolts, damaged bearing retainers, companion flange bolts, washers or nuts or use inferior grade bolts. Reuse of bearing retainer bolts, damaged bearing retainers, companion flange bolts, washers or nuts or the use of inferior grade bolts can cause driveline failure, which can result in separation of driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.*

6. Remove driveshaft from support straps and take it to a work bench area. ▲ See warning, below. If the driveshaft was the section of the driveline assembly with the effected universal joint, proceed to step 15, page 78.

▲ ***WARNING***

Driveshaft assemblies can weigh in excess of 100 pounds (46 kilograms). Make sure to use proper lifting techniques when handling driveshafts. More than one person may be needed when handling driveshaft assemblies.

Disconnect Coupling Shaft(s)

7. **Be sure the third and fourth support straps are in proper position as illustrated in Figure N, P or Q, page 73.**

8. Remove bearing retainers and bolts or companion flange bolts, washers and nuts at the center bearing end fitting. Discard bearing retainer bolts or companion flange bolts, washers and nuts.

Bearing retainers **CAN** be reused **if there is no damage**. If damaged, replace. ▲ See warning, step 5.

Bearing retainer bolts or companion flange bolts, washers or nuts **CANNOT** be reused. Discard bolts, washers and nuts and replace with new. ▲ See warning, step 5.

Remove Coupling Shaft(s)

9. Remove center bearing bracket bolts. Allow shaft to rest on support straps.

10. Remove bearing retainers and bolts or companion flange bolts, washers and nuts at next center bearing end fitting. Discard bearing retainer bolts or companion flange bolts, washers and nuts. ▲ See warning, step 5.

11. It may be necessary to unseat bearing cup assemblies, pilot or serrated connections by tapping on tube yokes or bearing cups with a soft-faced hammer. Once bearing cup assemblies or connections are free, remove coupling shaft from support straps and take it to a work bench area. ▲ See warning, below. If the coupling shaft was the section of the driveline assembly with the effected universal joint, proceed to step 15, page 78.

Note – It may be necessary to repeat steps 7-11 in order to access the coupling shaft with the effected universal joint.

▲ ***WARNING***

Driveshaft assemblies can weigh in excess of 100 pounds (46 kilograms). Make sure to use proper lifting techniques when handling driveshafts. More than one person may be needed when handling driveshaft assemblies.

Disconnect Final Position Coupling Shaft

12. **Be sure the fifth and sixth support straps are in place as illustrated in Figure N, P, or Q, page 73.** Remove final center bearing bracket bolts. Allow shaft to rest on support straps.

Remove Final Position Coupling Shaft

13. Remove bearing retainer bolts or companion flange bolts, washers and nuts from front end fitting. Discard bearing retainer bolts or companion flange bolts, washers and nuts. ▲ See warning, below.

Bearing retainers **CAN** be reused **if there is no damage**. If damaged, replace. ▲ See warning, below.

Bearing retainer bolts or companion flange bolts, washers or nuts **CANNOT** be reused. Discard bolts, washers and nuts and replace with new. ▲ See warning, below.

▲ ***WARNING***

DO NOT *reuse bearing retainer bolts, damaged bearing retainers, companion flange bolts, washers or nuts or use inferior grade bolts. Reuse of bearing retainer bolts, damaged bearing retainers, companion flange bolts, washers or nuts or the use of inferior grade bolts can cause driveline failure, which can result in separation of driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.*

14. It may be necessary to unseat bearing cup assemblies, pilot or serrated connections by tapping on tube yokes or bearing cups with a soft-faced hammer. Once bearing cup assemblies or connections are free, remove final position coupling shaft from support straps and take it to a work bench area. ▲ See warning, step 11.

Photo 56, Quick Disconnect Style

Photo 57, Companion Flange Style

Remove Universal Joint Kit

15. Remove and discard spring tabs and bolts. Reference bolt specifications, Table X, right. (See photos 56 or 57, above). ▲ See warning, below.

Companion Flange/Flange Yoke Style (S.A.E., DIN and T-Type)

If using an arbor press, proceed to step 16.

Quick Disconnect™ Style

If using an arbor press, proceed to step 20.

If using a universal joint puller, follow manufacturer's instructions.

▲ ***WARNING***

DO NOT *reuse spring tabs, spring tab bolts or use inferior grade bolts. Reuse of spring tabs, spring tab bolts and use of inferior grade bolts, can cause driveline failure, which can result in separation of driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.*

SPRING TAB BOLT SPECIFICATIONS

SERIES	THREAD SIZE	HEAD SIZE	BOLT TORQUE Nm	BOLT TORQUE LB. FT.	KIT P/N*
SPL140	8mm x 1.00	8mm, 6 point	35-40	25-30	211941X
SPL170	8mm x 1.00	8mm, 6 point	35-40	25-30	211941X
SPL250	8mm x 1.00	8mm, 6 point	35-40	25-30	211941X

** Bolts are specially heat-treated.*
DO NOT substitute with inferior grade bolts.

Table X

Photo 58, Companion Flange Style

Photo 59, Companion Flange Style

Companion Flange/Flange Yoke Style (S.A.E., DIN and T-Type) Style

16. To remove flange yoke, place bearing cup spacer onto the base of the arbor press and under flange yoke. (See photo 58, above.) If the arbor is larger than the bearing cup diameter, a smaller diameter push rod will be needed to avoid damaging the yoke or bearing.

Using an arbor press, press down on the upper bearing cup assembly until the shoulder of the journal cross makes contact with the inside of flange yoke ear. (See photo 58, above.)

Caution – DO NOT over press the bearing cup and journal cross. This can damage the inside of the yoke ear.

17. Bearing cup is not designed to drop out of flange yoke. It will be necessary to use a soft-faced hammer to tap the partially pressed-out bearing cup from side to side, to "walk" the bearing cup out of flange yoke ear. (See photo 59, top right.)

Remove the bearing cup from flange yoke ear and trunnion.

18. Place flange yoke in arbor press with remaining bearing cup face down. Using a push rod, press on end of the journal cross trunnion until the shoulder of the journal cross makes contact with the inside of flange yoke ear. (See photo 60, below.) Repeat step 17.

19. Remove flange yoke from journal cross. Continue to Quick Disconnect™ style, step 21, for complete removal of universal joint.

Photo 60

Photo 61, Correct Positioning

Photo 62, Incorrect Positioning

Quick Disconnect™ Style

20. Remove the outboard bearing cup assemblies.

21. Make sure universal joint cross assembly is not tilted in the yoke. (See photos 61 and 62, above.) Place bearing cup spacer onto the base of the arbor press and under the yoke. If the arbor is larger than the bearing cup diameter, a smaller diameter push rod will be needed to avoid damaging the yoke or bearing.

Using an arbor press, press down on the upper bearing cup assembly until the shoulder of the journal cross makes contact with the inside of the yoke ear. (See photo 63, below.)

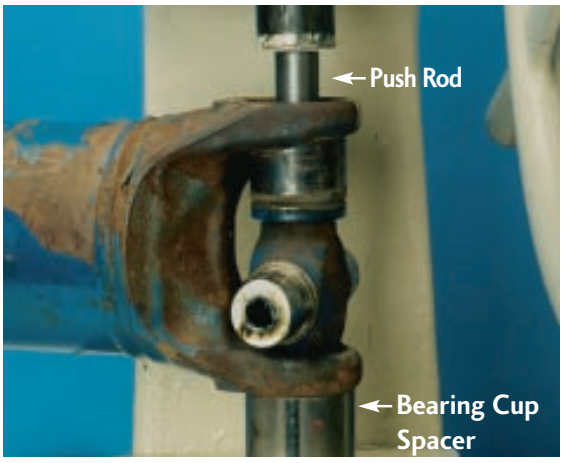


Photo 63

Caution – DO NOT over press the bearing cup and journal cross. This can damage the inside of the yoke ear.

22. The bearing cup is not designed to drop out of the yoke. It will be necessary to use a soft-faced hammer to tap the partially pressed-out bearing cup from side to side, to "walk" the bearing cup out of the yoke ear. (See photo 64, below.)

Remove the bearing cup from the trunnion.

Photo 64

Photo 65

Photo 66

23. Place the yoke in the press, with the remaining bearing cup face down. (See photo 65, above.) Using a push rod, press on end of the journal cross trunnion. Continue to press down on the journal cross trunnion until the shoulder of the journal cross makes contact with the inside of the yoke ear.

24. Repeat step 22.

25. Remove the journal from the yoke.

Inspect Tube Yoke and Flange Yoke (if applicable)

26. Inspect the tube yoke and flange yoke (if applicable) cross hole surfaces for damage or raised metal. Raised metal or fretting can be removed from yoke cross holes with a fine-toothed file and/or emery cloth. (See photo 66, top right.) ▲ See warning, below.

▲ ***WARNING***

DO NOT *deform yoke cross holes by removing excessive metal. Raised metal or deformed yoke cross holes can be a cause of cross and bearing problems and can result in separation of driveline from vehicle. A separated driveline can result in property damage, serious personal injury or death.*

27. Inspect the tube yoke or flange yoke (if applicable) for distorted cross holes using an appropriate Spicer alignment bar. Slide alignment bar through both cross holes simultaneously. If alignment bar will not pass through both cross holes simultaneously, the cross holes are distorted and the shaft assembly must be replaced. (See photo 67, below.) ▲ See warning, below.

▲ ***WARNING***

Failure to replace a damaged driveline can cause driveline failure, which can result in separation of driveline from vehicle. A separated driveline can result in property damage, serious personal injury or death.

Photo 67

Install New Universal Joint Kit

28. Proceed to installation of universal joint kits, spring tab style, pages 116 to 121.

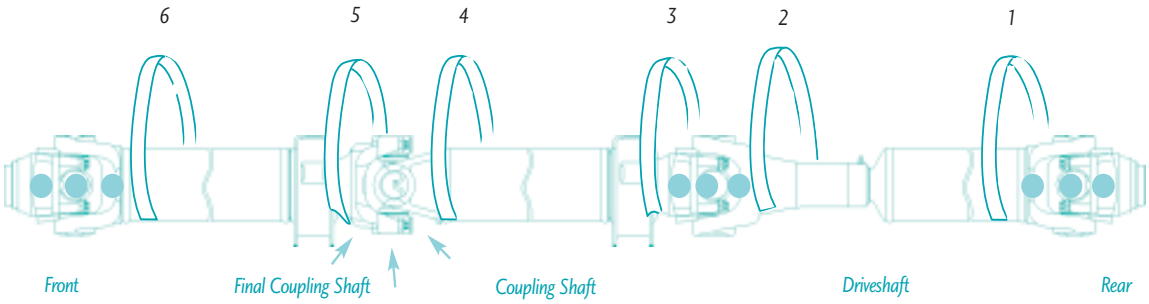


Figure R, Quick Disconnect

SNAP RING STYLE SPICER LIFE SERIES™ 55, 70, 90, AND 100

Caution – Be sure to carefully read all information on page 39 before proceeding.

Note – When working with multiple-piece driveshafts, it may be necessary to remove the entire driveline assembly to reach the effected universal joint. Work from the rear end forward. The driveshaft will need to be disconnected to allow clearance for the removal of any coupling shaft. Work on only one connection at a time. Be sure to properly position support straps.

Note – For more detailed driveshaft assembly removal procedures, see removal of driveshaft assemblies in table of contents.

Mark Driveshaft ("Phasing Marks")

1. It is imperative to mark all mating components of the driveshaft or coupling shaft with the effected universal joint(s). Mark the driveshaft or coupling shaft with a marking stick, paint marker or other legible marking device. In addition, be sure to mark bearing positions. This assures proper reassembly of the driveshaft or coupling shaft into the vehicle, in its original position. ▲ See warning, below.

▲ ***WARNING***

Reassembly of a driveline out of original phase can cause vibration and failure of the driveline and attaching components. Failure of a driveline can result in separation of driveline from the vehicle, which can result in property damage, serious personal injury or death.

Position Support Straps

2. Working on the driveshaft assembly section with the effected universal joint(s), place support straps as illustrated in Figure R, above.

Driveshaft

Be sure to position support straps 1 and 2. ▲ See warning, below.

Coupling Shaft(s)

Be sure to position support straps 2, 3 and 4. ▲ See warning, below.

Final Position Coupling Shaft

Be sure to position support straps 4, 5 and 6. ▲ See warning, below.

▲ ***WARNING***

ALWAYS *use support straps to prevent driveshaft from falling out of vehicle. Failure to use support straps can cause damage to driveshaft or result in property damage, serious personal injury or death.*

Attach support straps to frame rails or some structural part of the vehicle. **DO NOT** attach the support straps to fuel lines, oil lines, brake lines, or wiring. **DO NOT** entangle fuel lines, oil lines, brake lines, or wiring in the support straps. ▲ See warning, below.

▲ ***WARNING***

Attaching or entangling support straps to fuel, oil or brake lines or wiring can result in their damage. Damaged fuel, oil or brake lines or wiring can result in failure of the vehicle, which can result in property damage, serious personal injury or death.

For removal of a **driveshaft** with an effected universal joint, follow steps 3-6.

For removal of **coupling shaft(s)** with an effected universal joint, follow steps 3-11.

For removal of **final position coupling shafts** with an effected universal joint, follow steps 3-14.

Disconnect Driveshaft

3. Remove bearing retainers or stamped straps. Discard stamped straps, bearing retainer bolts, stamped strap bolts or companion flange bolts, washers and nuts at the effected universal joint. Reference bolt specifications, Table Y, above right, or hardware specifications Table Z, page 84.

QUICK DISCONNECT™ BOLT SPECIFICATIONS

SERIES	BOLT P/N*	THREAD SIZE	HEAD SIZE	BOLT TORQUE Nm	BOLT TORQUE LB. FT.
SPL55	TBD	TBD	TBD	TBD	TBD
SPL70	TBD	TBD	TBD	TBD	TBD
SPL90	6-73-412	0.375 in. - 24	3/8 in., 12 point	61-81	45-60
SPL100	TBD	TBD	TBD	TBD	TBD
SPL140	12-73-125M	12mm - 1.25	12 mm, 12 point	135-160	100-120
SPL170	12-73-125M	12mm - 1.25	12 mm, 12 point	135-160	100-120
SPL250	12-73-125M	12mm - 1.25	12 mm, 12 point	135-160	100-120

** Bolts are specially heat-treated.*
DO NOT substitute with inferior grade bolts.

Table Y

Bearing retainers **CAN** be reused **if there is no damage**. (See photo 68, below.) If damaged, replace with new. ▲ See warning, below.

Stamped straps (see photo 69, below), bearing retainer bolts, stamped strap bolts or companion flange bolts, washers and nuts **CANNOT** be reused. Discard stamped straps and bolts or companion flange bolts, washers and nuts and replace with new. ▲ See warning, below

Photo 68, Bearing Retainers

Photo 69, Stamped Straps

▲ ***WARNING***

DO NOT *reuse bearing retainer or stamped strap bolts, stamped straps, companion flange bolts, washers or nuts or use inferior grade bolts. Reuse of bearing retainer or stamped strap bolts, stamped straps, companion flange bolts, washers or nuts or the use of inferior grade bolts can cause driveline failure, which can result in separation of driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.*

COMPANION FLANGE/FLANGE YOKE STYLE (S.A.E., DIN AND T-TYPE) HARDWARE SPECIFICATIONS

SERIES	BOLT P/N*†	WASHER P/N	NUT P/N	DIAMETER, THREAD & LENGTH UNDER HEAD	BOLT TORQUE Nm	BOLT TORQUE FT. LBS.
SPL55	TBD	TBD	TBD	TBD	TBD	TBD
SPL70	TBD	TBD	TBD	TBD	TBD	TBD
SPL90	6-73-1219	500357-11	231421-3	.375" 24 x 1.188"	54-65	40-48
SPL100	TBD	TBD	TBD	TBD	TBD	TBD
SPL140	6-73-220	500357-11	231421-3	.375" 24 x 1.250"	54-65	40-48
	6-73-1227	500357-11	231421-3	.375" 24 x 1.688"	54-65	40-48
SPL170	7-73-122	500357-12	231421-4	.438" 20 x 1.375"	85-102	63-75
	7-73-228	500357-12	231421-4	.438" 20 x 1.750"	85-102	63-75
SPL250	7-73-122	500357-12	231421-4	.438" 20 x 1.375"	85-102	63-75
	7-73-228	500357-12	231421-4	.438" 20 x 1.750"	85-102	63-75

**Bolts are specially heat-treated. DO NOT substitute inferior grade bolts.*

† Approved Spicer hardware.

***Note**-Original equipment vehicle manufacturers' manuals may have alternate specified bolts or metric hardware. Refer to the original equipment service manual for bolt part numbers.*

Table Z

4. It may be necessary to unseat bearing cup assemblies, pilot or serrated connection by tapping on tube yoke or bearing cup with a soft-faced hammer. Once the bearing cup assemblies or connections are free, collapse the driveshaft until both bearing cup assemblies clear the open yoke cross or flange yoke pilot is disconnected. Allow the driveshaft to rest on support strap.

Remove Driveshaft

5. **Be sure the second support strap is in place as illustrated in Figure R, page 82.** Remove bearing retainers or stamped straps and bolts or companion flange bolts, washers and nuts at the opposite end of the driveshaft. Reference bolt specifications Table Y, page 83, or hardware specifications, Table Z, above. Discard stamped straps and bearing retainer or stamped strap bolts or companion flange bolts, washers and nuts.

Stamped straps, bearing retainer bolts, stamped strap bolts, or companion flange bolts, washers and nuts **CANNOT** be reused. Discard stamped straps and bolts or companion flange bolts, washers and nuts and replace with new. See warning, below.

WARNING

***DO NOT** reuse bearing retainer or stamped strap bolts, stamped straps, damaged bearing retainers, companion flange bolts, washers or nuts or use inferior grade bolts. Reuse of bearing retainer or stamped strap bolts, stamped straps, damaged bearing retainers, companion flange bolts, washers or nuts or the use of inferior grade bolts can cause driveline failure, which can result in separation of driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.*

6. Remove driveshaft from support straps and take it to a work bench area. ▲ See warning, below. If the driveshaft was the section of the driveline assembly with the effected universal joint, proceed to step 15, page 86.

▲ ***WARNING***

Driveshaft assemblies can weigh in excess of 100 pounds (46 kilograms). Make sure to use proper lifting techniques when handling driveshafts. More than one person may be needed when handling driveshaft assemblies.

Disconnect Coupling Shaft(s)

7. **Be sure the third and fourth support straps are in proper position as illustrated in Figure R, page 82.**

8. Remove bearing retainers or stamped straps. Discard stamped straps, bearing retainer bolts, stamped strap bolts or companion flange bolts, washers and nuts at the center bearing end fitting.

Bearing retainers **CAN** be reused **if there is no damage.** If damaged, replace. ▲ See warning, below.

Stamped straps, bearing retainer, stamped strap bolts or companion flange bolts, washers and nuts **CANNOT** be reused. Discard stamped straps and bolts or companion flange bolts, washers and nuts and replace with new. ▲ See warning, below.

▲ ***WARNING***

DO NOT *reuse bearing retainer or stamped strap bolts, stamped straps, damaged bearing retainers, companion flange bolts, washers or nuts or use inferior grade bolts. Reuse of bearing retainer or stamped strap bolts, stamped straps, damaged bearing retainers, companion flange bolts, washers or nuts or the use of inferior grade bolts can cause driveline failure, which can result in separation of driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.*

Remove Coupling Shaft(s)

9. Remove center bearing bracket bolts. Allow shaft to rest on support straps.

10. Remove bearing retainers and bearing retainer bolts or stamped straps and bolts or companion flange bolts, washers and nuts at next center bearing position. Discard all stamped straps, bearing retainer or stamped strap or companion flange bolts, washers, and nuts. ▲ See warning, step 8.

11. It may be necessary to unseat bearing cup assemblies, pilot or serrated connections by tapping on tube yokes or bearing cups with a soft-faced hammer. Once bearing cup assemblies or connections are free, remove coupling shaft from support straps and take it to a work bench area. ▲ See warning, step 6. If the coupling shaft was the section of the driveline assembly with the effected universal joint, proceed to step 15, page 86.

Note – It may be necessary to repeat steps 7-11 in order to access the coupling shaft with the effected universal joint.

Disconnect Final Position Coupling Shaft

12. **Be sure fifth and sixth support straps are in place as illustrated in Figure R, page 82.** Remove final center bearing bracket bolts. Allow shaft to rest on support straps.

Remove Final Coupling Shaft

13. Remove and discard bearing retainers or stamped straps and bolts or companion flange bolts, washers and nuts from front end fitting. ▲ See warning, step 8.

Bearing retainers **CAN** be reused **if there is no damage.** If damaged, replace. ▲ See warning, step 8.

Photo 70

14. It may be necessary to unseat bearing cup assemblies, pilot or serrated connection by tapping on tube yoke or bearing cup with a soft-faced hammer. Once bearing cup assemblies or connection is free, remove final position coupling shaft from support straps and take it to a work bench area. See warning, below.

WARNING

Driveshaft assemblies can weigh in excess of 100 pounds (46 kilograms). Make sure to use proper lifting techniques when handling driveshafts. More than one person may be needed when handling driveshaft assemblies.

Remove Universal Joint Kit(s)

15. Using snap-ring pliers, remove all snap rings. (See photo 70, above.) If snap rings are severely corroded or out-of-round, snap rings must be replaced. See warning, below.

WARNING

***DO NOT** reuse severely corroded or out-of-round snap rings. Reuse of snap rings can cause universal joint failure and can result in separation of the driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.*

Companion Flange/Flange Yoke Style (S.A.E., DIN and T-Type)

If using an arbor press, proceed to step 16.

Quick Disconnect™ Style

If using an arbor press, proceed to step 20.

If using a universal joint puller, follow manufacturers' instructions.

Companion Flange/Flange Yoke Style (S.A.E., DIN and T-Type) Style

16. To remove flange yoke, place bearing cup spacer onto the base of the arbor press and under flange yoke. If the arbor is larger than the bearing cup diameter, a smaller diameter push rod will be needed to avoid damaging the yoke or bearing.

Using an arbor press, press down on the upper bearing cup assembly until the shoulder of the journal cross makes contact with the inside of flange yoke ear.

Caution – DO NOT over press the bearing cup and journal cross. This can damage the inside of the yoke ear.

17. Bearing cup is not designed to drop out of flange yoke. It will be necessary to use a soft-faced hammer to tap the partially pressed-out bearing cup from side to side, to "walk" the bearing cup out of flange yoke ear.

Remove the bearing cup from flange yoke ear and trunnion.

18. Place flange yoke in arbor press with remaining bearing cup face down. Using a push rod, press on end of the journal cross trunnion until the shoulder of the journal cross makes contact with the inside of flange yoke ear. Repeat step 17.

19. Remove flange yoke from journal cross. Continue to Quick Disconnect™ style, step 21, for complete removal of universal joint.

Photo 71, Correct Positioning

Photo 72, Incorrect Positioning

Quick Disconnect™ Style

20. Remove the outboard bearing cup assemblies.

21. Make sure the universal joint cross assembly is not tilted in yoke. (See photos 71, top left, and 72, center left.)

22. Place bearing cup spacer onto the base of the arbor press and under the yoke. If the arbor is larger than the bearing cup diameter, a smaller diameter push rod will be needed to avoid damage to the yoke or bearing.

Using the arbor press, press down on the upper bearing cup assembly until the shoulder of the journal cross makes contact with the inside of the yoke ear. (See photo 73, bottom left.) Bearing cup is not designed to drop out of yoke.

Caution – **DO NOT** over press the bearing cup and journal cross. This can damage the inside of the yoke ear.

23. Grip the bearing cup in bench vice. (See photo 74, below.) Strike the yoke ear with a soft-faced hammer until bearing is removed.

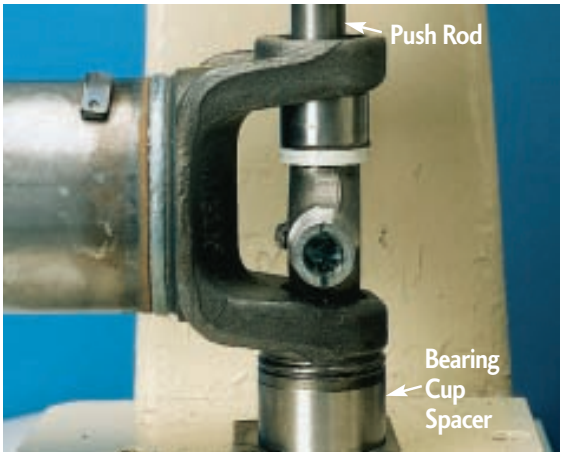


Photo 73

Photo 74

24. Place the yoke in the arbor press with remaining bearing cup face down. Using a push rod, press on the end of journal cross trunnion. (See photo 75, top right.) Continue to press down on journal cross trunnion until the shoulder of the journal cross makes contact with the inside of yoke ear. Bearing cup is not designed to drop out of yoke. Repeat step 23.

25. Remove journal cross from yoke.

Inspect Tube Yoke and Flange Yoke (if applicable)

26. Inspect the tube yoke and flange yoke (if applicable) cross hole surfaces for damaged or raised metal. Raised metal or fretting can be removed from yoke cross holes with a fine-toothed file and/or emery cloth. (See photo 76, right.) See warning, below.

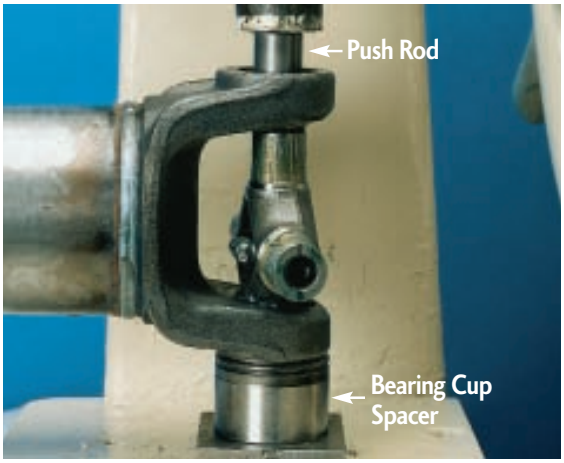


Photo 75


Photo 76

WARNING

DO NOT *deform yoke cross holes by removing excessive metal. Raised metal or deformed yoke cross holes can be a cause of cross and bearing problems and can result in separation of driveline from vehicle. A separated driveline can result in property damage, serious personal injury or death.*

27. Inspect the yoke for distorted cross holes using the appropriate Spicer alignment bar. Slide alignment bar through both cross holes simultaneously. If alignment bar will not pass through both cross holes simultaneously, cross holes are distorted and the shaft assembly must be replaced. See warning, below.

WARNING

Failure to replace a damaged driveline can cause driveline failure, which can result in separation of driveline from vehicle. A separated driveline can result in property damage, serious personal injury or death.

Install New Universal Joint Kit

28. Proceed to installation of universal joint kits, snap ring style, pages 122 to 127.

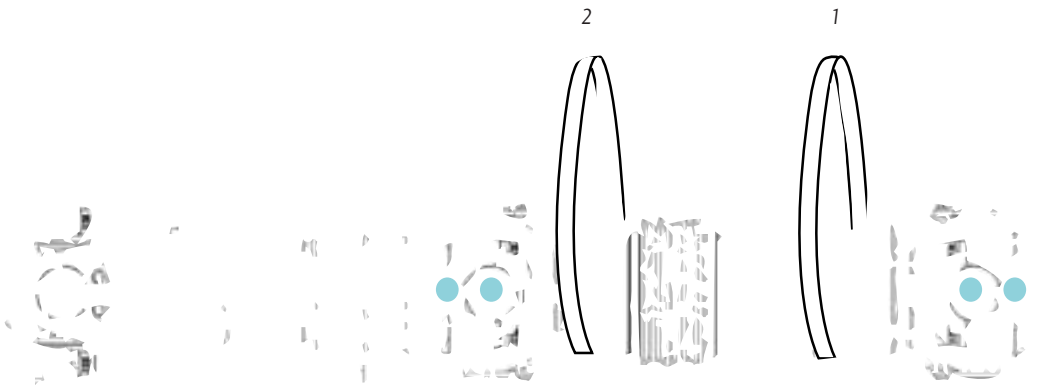


Figure S, Quick Disconnect

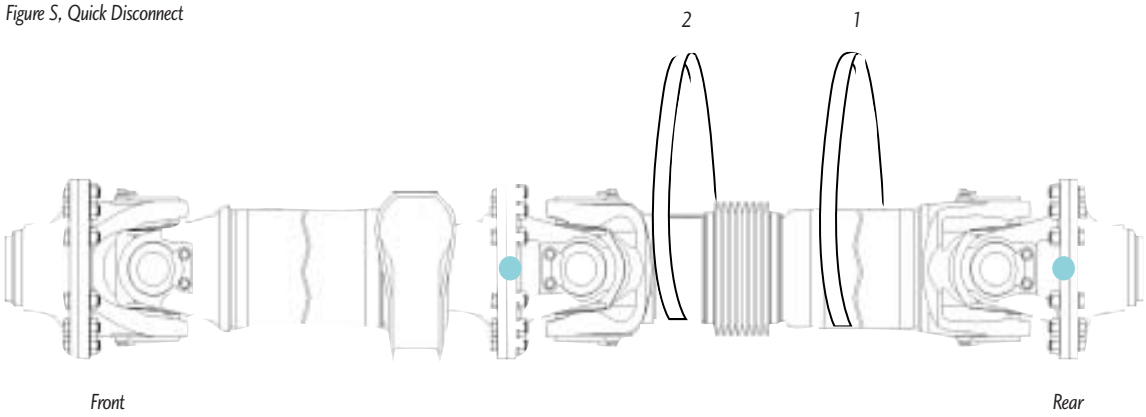


Figure T, S.A.E.

REPLACEMENT PROCEDURE FOR DAMAGED SLIP MEMBER BOOT

SPICER LIFE SERIES™ 55, 70, 100, 140, 170 & 250

Caution – Be sure to carefully read all information on page 39 before proceeding.

Required Tools

- Support Straps
- Ratchet or Air Gun
- 12-Point Sockets
  English 3/8", or
  Metric 12mm
- Soft-Faced Hammer
- Chisel

Caution – Seal can style slip member assemblies are **NOT** serviceable. If seal can or seal is damaged, replacement of the complete driveshaft assembly is necessary. (See Figure U, below.)

Figure U

Mark Driveshaft ("Phasing Marks")

1. It is imperative to mark all mating components of the driveshaft, as illustrated in Figure S or T, above, for the appropriate style driveshaft being serviced. Mark the driveshaft with a marking stick, paint marker or other legible marking device.

For Quick Disconnect™ style, be sure to mark all the bearing positions, spline positions, shaft locations and bearing retainers (if applicable).

For companion flange/flange yoke (S.A.E.) style, be sure to mark all the flange positions, spline positions and shaft locations. This assures proper reassembly of the driveshaft into the vehicle, in its original position. ▲ See warning, below.

▲ ***WARNING***

Reassembly of a driveline out of original phase can cause vibration and failure of the driveline and attaching components. Failure of a driveline can result in separation of driveline from the vehicle, which can result in property damage, serious personal injury or death.

Position Support Straps

2. Working from the **rear**, position support straps 1 and 2 as illustrated in Figure S or T, page 89, for the appropriate style of driveshaft being serviced. ▲ See warning, below.

▲ ***WARNING***

ALWAYS *use support straps to prevent driveshaft from falling out of vehicle. Failure to use support straps can cause damage to driveshaft or result in property damage, serious personal injury or death.*

Attach support straps to frame rails or some structural part of the vehicle. **DO NOT** attach support straps to gas lines, oil lines, brake lines, or wiring. **DO NOT** entangle gas lines, oil lines, brake lines, or wiring in support straps. ▲ See warning, below.

▲ ***WARNING***

Attaching or entangling support straps to fuel, oil or brake lines or wiring can result in their damage. Damaged fuel, oil or brake lines or wiring can result in failure of the vehicle, which can result in property damage, serious personal injury or death.

Photo 77

Remove Boot Clamps

3. Remove and discard both boot clamps. Clamps may be separated using a chisel to disengage locking hooks. (See photo 77, above.) **DO NOT reuse clamps**. ▲ See warning, below.

▲ ***WARNING***

Reuse of boot clamps could allow intrusion of contaminants into slip member and can cause driveline failure, which can result in separation of the driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.

Clean and Mark Spline Sleeve and Weld Ring

Caution – The following step is an additional marking process to that described in step one. Be sure to mark as directed.

4. Completely collapse the boot toward the yoke shaft to expose weld ring and spline sleeve area. Wipe weld ring and spline sleeve areas clean.

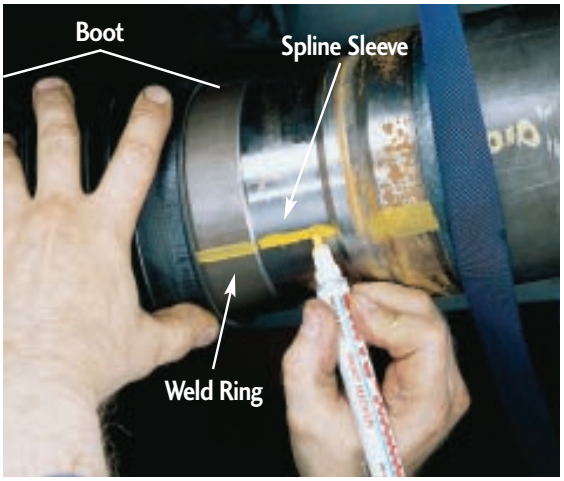


Photo 78

Photo 79

5. Mark spline sleeve and end of weld ring with a marking stick, paint marker or other legible marking device. (See photo 78, above.) This assures that the slip member can be reassembled in its original phased condition. ▲ See warning, below.

▲ ***WARNING***

Reassembly of a driveline out of original phase can cause vibration and failure of the driveline and attaching components. Failure of a driveline can result in separation of driveline from the vehicle, which can result in property damage, serious personal injury or death.

Disconnect Driveshaft

6. For Quick Disconnect™ style, remove bearing retainers and bolts or stamped straps and bolts at center bearing end fitting. Reference bolt specifications, Table AA, right. (See photo 79, top right.) Discard bolts.

QUICK DISCONNECT™ BOLT SPECIFICATIONS

SERIES	BOLT P/N*	THREAD SIZE	HEAD SIZE	BOLT TORQUE Nm	BOLT TORQUE LB. FT.
SPL55	TBD	TBD	TBD	TBD	TBD
SPL70	TBD	TBD	TBD	TBD	TBD
SPL90	6-73-412	0.375 in. - 24	3/8 in., 12 point	61-81	45-60
SPL100	TBD	TBD	TBD	TBD	TBD
SPL140	12-73-125M	12mm - 1.25	12 mm, 12 point	135-160	100-120
SPL170	12-73-125M	12mm - 1.25	12 mm, 12 point	135-160	100-120
SPL250	12-73-125M	12mm - 1.25	12 mm, 12 point	135-160	100-120

** Bolts are specially heat-treated.*
DO NOT substitute with inferior grade bolts.

Table AA

Bearing retainers **CAN** be reused **if there is no damage**. If damaged, replace. Stamped straps **CANNOT** be reused. **DO NOT** reuse the bolts. Discard bolts. ▲ See warning, below.

▲ ***WARNING***

DO NOT *reuse bearing retainer bolts, damaged bearing retainers, stamped straps or stamped strap bolts or use inferior grade bolts. Reuse of bearing retainer bolts, damaged bearing retainers, stamped straps or stamped strap bolts or the use of inferior grade bolts can cause driveline failure, which can result in separation of driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.*

COMPANION FLANGE/FLANGE YOKE STYLE (S.A.E., DIN AND T-TYPE) HARDWARE SPECIFICATIONS

SERIES	BOLT P/N*†	WASHER P/N	NUT P/N	DIAMETER, THREAD & LENGTH UNDER HEAD	BOLT TORQUE Nm	BOLT TORQUE FT. LBS.
SPL55	TBD	TBD	TBD	TBD	TBD	TBD
SPL70	TBD	TBD	TBD	TBD	TBD	TBD
SPL90	6-73-1219	500357-11	231421-3	.375" 24 x 1.188"	54-65	40-48
SPL100	TBD	TBD	TBD	TBD	TBD	TBD
SPL140	6-73-220	500357-11	231421-3	.375" 24 x 1.250"	54-65	40-48
	6-73-1227	500357-11	231421-3	.375" 24 x 1.688"	54-65	40-48
SPL170	7-73-122	500357-12	231421-4	.438" 20 x 1.375"	85-102	63-75
	7-73-228	500357-12	231421-4	.438" 20 x 1.750"	85-102	63-75
SPL250	7-73-122	500357-12	231421-4	.438" 20 x 1.375"	85-102	63-75
	7-73-228	500357-12	231421-4	.438" 20 x 1.750"	85-102	63-75

**Bolts are specially heat-treated. DO NOT substitute inferior grade bolts.*
† Approved Spicer hardware.
Note-*Original equipment vehicle manufacturers' manuals may have alternate specified bolts or metric hardware. Refer to the original equipment service manual for bolt part numbers.*

Table BB

For companion flange/flange yoke (S.A.E.) style, remove and discard flange bolts, washers and nuts. Reference bolt specifications, Table BB, above. See warning, below.

WARNING

***DO NOT** reuse flange bolts, washers or nuts or use inferior grade bolts. Reuse of flange bolts, washers and nuts or the use of inferior grade bolts can cause driveline failure, which can result in separation of driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.*

7. For Quick Disconnect™ style, it may be necessary to unseat bearing cup assemblies by tapping on one bearing cup with a soft-faced hammer. Once the bearing cup assemblies are free, collapse the driveshaft until both bearing assemblies clear the open yoke cross holes. Allow the driveshaft to rest on support straps. See warning, below.

For companion flange/flange yoke (S.A.E.) style, it may be necessary to unseat pilot or serrated connection by tapping on one side of the flange with a soft-faced hammer. Allow the driveshaft to rest on support straps. See warning, below.

WARNING

Driveshaft assemblies can weigh in excess of 100 pounds (46 kilograms). Make sure to use proper lifting techniques when handling driveshafts. More than one person may be needed when handling driveshaft assemblies.

Photo 80

Remove Slip Member Boot

8. Remove the yoke shaft and boot from the spline sleeve. Discard boot. (See photo 80, above.) ▲ See warning, below.

▲ ***WARNING***

Yoke shaft assemblies can weigh in excess of 50 pounds (23 kilograms). Make sure to use proper lifting techniques when handling yoke shafts.

Inspect Yoke Shaft and Spline Sleeve

9. Inspect the yoke shaft spline surface for damage. If the splines are damaged, missing or twisted, or any Glidecote® is missing, complete driveshaft replacement is necessary. ▲ See warning, below.

▲ ***WARNING***

Failure to replace damaged driveline components can cause driveline failure, which can result in separation of driveline from vehicle. A separated driveline can result in property damage, serious personal injury or death.

10. Inspect the spline sleeve for damage. If the splines are damaged, missing or twisted, complete driveshaft replacement is necessary. ▲ See warning, step 9.

11. Inspect the entire slip assembly for contaminants. If the slip assembly shows evidence of rust or the lube is severely contaminated, complete driveshaft replacement is necessary. ▲ See warning, step 9.

Reassemble Slip Member Boot

12. Proceed to installation of slip member boot, pages 133 to 135.

REMOVAL PROCEDURE FOR CENTER BEARINGS

SPICER LIFE SERIES™ 55, 70, 90, 100, 140, 170 & 250

Caution – Be sure to carefully read all information on page 39 before proceeding.

Required Tools

- Support Straps
- Bearing Puller
- Flange or Yoke Puller
- 6-Point Socket for Midship Nut
- 12-Point Sockets
  English 3/8", or
  Metric 12mm
- Spicer Alignment Bar (see photo 81 or 82, top right and right)

Photo 81, Spicer Alignment Bar Kit, Quick Disconnect Style

Photo 82, Spicer Alignment Bar, Companion Flange/Flange Yoke Style

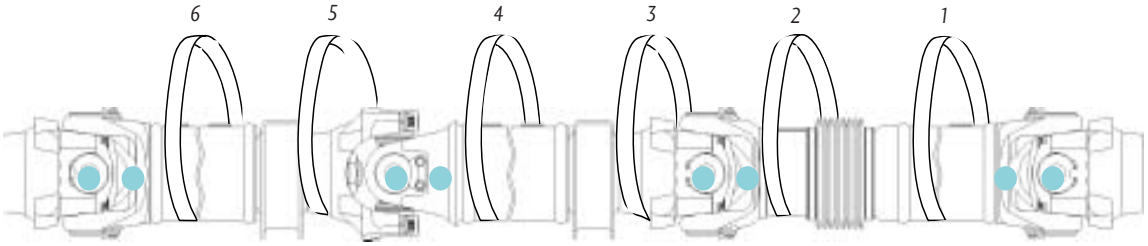


Figure V, Quick Disconnect™

QUICK DISCONNECT™ YOKE STYLE

Caution – Be sure to carefully read all information on page 39 before proceeding.

Note – When working with multiple-piece driveshafts, it may be necessary to remove the entire driveline assembly. Work from the rear end forward. The driveshaft will need to be disconnected to allow clearance for the removal of any coupling shaft. Work on only one connection at a time. Be sure to properly position support straps.

Mark Driveshaft ("Phasing Marks")

1. It is imperative to mark all mating components of the driveshaft, as illustrated in Figure V, above. Mark the driveshaft with a marking stick, paint marker or other legible marking device. In addition, be sure to mark all bearing positions, spline positions, shaft locations and all bearing retainers. This assures proper reassembly of the driveshaft into the vehicle, in its original position. ▲ See warning, below.

▲ ***WARNING***

Reassembly of a driveline out of original phase can cause vibration and failure of the driveline and attaching components. Failure of a driveline can result in separation of driveline from the vehicle, which can result in property damage, serious personal injury or death.

Position Support Straps

2. Working from the **rear** end forward, position support straps 1 through 6 (as needed) as illustrated in Figure V, above. ▲ See warning, below.

▲ ***WARNING***

***ALWAYS** use support straps to prevent driveshaft from falling out of vehicle. Failure to use support straps can cause damage to driveshaft or result in property damage, serious personal injury or death.*

Attach support straps to frame rails or some structural part of the vehicle. **DO NOT** attach support straps to gas lines, oil lines, brake lines, or wiring. **DO NOT** entangle gas lines, oil lines, brake lines, or wiring in support straps. ▲ See warning, below.

▲ ***WARNING***

Attaching or entangling support straps to fuel, oil or brake lines or wiring can result in their damage. Damaged fuel, oil or brake lines or wiring can result in failure of the vehicle, which can result in property damage, serious personal injury or death.

QUICK DISCONNECT™ BOLT SPECIFICATIONS

SERIES	BOLT P/N*	THREAD SIZE	HEAD SIZE	BOLT TORQUE Nm	BOLT TORQUE LB. FT.
SPL55	TBD	TBD	TBD	TBD	TBD
SPL70	TBD	TBD	TBD	TBD	TBD
SPL90	6-73-412	0.375 in. - 24	3/8 in., 12 point	61-81	45-60
SPL100	TBD	TBD	TBD	TBD	TBD
SPL140	12-73-125M	12mm - 1.25	12 mm, 12 point	135-160	100-120
SPL170	12-73-125M	12mm - 1.25	12 mm, 12 point	135-160	100-120
SPL250	12-73-125M	12mm - 1.25	12 mm, 12 point	135-160	100-120

** Bolts are specially heat-treated.*
DO NOT substitute with inferior grade bolts.

Table CC

Photo 83

Disconnect Driveshaft

3. With all support straps securely in place, disconnect the driveshaft from the coupling shaft by removing the bearing retainers and bolts or stamped straps and bolts. Reference bolt specifications, Table CC, above. If bearing retainers are not damaged, they can be reused. Stamped straps **CANNOT** be reused. **DO NOT** reuse the bolts. Discard bolts. ▲ See warning, below.

▲ ***WARNING***

DO NOT *reuse bearing retainer bolts or damaged bearing retainers, stamped straps or stamped strap bolts, or use inferior grade bolts. Reuse of bearing retainer bolts or damaged bearing retainers, stamped straps or stamped strap bolts, or use of inferior grade bolts can cause driveline failure, which can result in separation of the driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.*

4. It may be necessary to unseat bearing cup assemblies by tapping on yoke or bearing cup with a soft-faced hammer. Once the bearing cup assemblies are free, collapse the driveshaft until both bearing assemblies clear the open yoke cross holes. Allow driveshaft to rest on support strap.

If disconnecting the driveshaft has allowed access to the effected center bearing, proceed to step 9. **DO NOT** at this point remove coupling shaft with the effected center bearing from the vehicle.

If the effected center bearing has not been reached, proceed to step 5 to remove coupling shaft(s) to reach coupling shaft with effected center bearing.

Remove Coupling Shaft(s)

5. **Be sure the third support strap is in place as illustrated in Figure V, page 95.** Remove the center bearing bracket bolts and allow the shaft to rest on the support strap. (See photo 83, above.)

6. **Be sure the fourth support strap is in place as illustrated in Figure V, page 95.** Remove bearing retainers or stamped straps and bolts on end yoke. Reference bolt specifications Table CC, left. Discard bolts. Discard stamped straps (if applicable). ▲ See warning, step 3.

7. It may be necessary to unseat bearing cup assemblies by tapping on yoke or bearing cup with a soft-faced hammer. Once coupling shaft is free, remove coupling shaft from support straps and take to a work bench area. ▲ See warning, below.

▲ ***WARNING***

Driveshaft assemblies can weigh in excess of 100 pounds (46 kilograms). Make sure to use proper lifting techniques when handling driveshafts. More than one person may be needed when handling driveshaft assemblies.

8. Repeat steps 5-7 as necessary to obtain access to the effected center bearing. **DO NOT** at this point remove coupling shaft with the effected center bearing from the vehicle.

Inspect Center Bearing End Yoke

9. Inspect the center bearing end yoke cross hole surfaces and bolt hole threads for damage. If the bolt hole threads are damaged, the yoke must be replaced. ▲ See warning, below.

▲ ***WARNING***

Failure to replace damaged driveline components can cause driveline failure, which can result in separation of driveline from vehicle. A separated driveline can result in property damage, serious personal injury or death.

10. Check the center bearing end yoke for looseness, backlash and broken back. Take hold of center bearing end yoke with both hands. Try to move it vertically and horizontally to feel any looseness. There should **NOT** be any movement in the center bearing end yoke relative to the midship tube shaft to which it is connected. If any of these conditions are present, the center bearing end yoke or midship tube shaft must be replaced. ▲ See warning, below.

▲ ***WARNING***

A loose end fitting can result in driveline failure, which can result in separation of driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.

11. Inspect the center bearing end yoke cross hole surfaces for damage or raised metal. Raised metal or fretting can be removed from yoke cross holes with a fine-toothed file and/or emery cloth. ▲ See warning, below.

▲ ***WARNING***

***DO NOT** deform yoke cross holes by removing excessive metal. Raised metal or deformed yoke cross holes can be a cause of cross and bearing failure, which can result in separation of driveline from vehicle. A separated driveline can result in property damage, serious personal injury or death.*

12. Inspect the center bearing end yoke for distorted cross holes using the appropriate Spicer alignment bar. Slide alignment bar through both cross holes simultaneously. If alignment bar will not pass through both cross holes simultaneously, cross holes are distorted and yoke must be replaced. ▲ See warning, step 9.

Note – If effected center bearing was in the final coupling shaft, repeat same inspection steps on front end yoke prior to reinstallation of final coupling shaft into vehicle.

MIDSHIP NUT SPECIFICATIONS

SERIES	NUT P/N	WASHER P/N	HEAD SIZE	NUT TORQUE Nm	NUT TORQUE LB. FT.
SPL55	TBD	TBD	TBD	TBD	TBD
SPL70	TBD	TBD	TBD	TBD	TBD
SPL90	231502	N/A	1 5/8"	644-712	475-525 Lb.Ft.
SPL100	TBD	TBD	TBD	TBD	TBD
SPL140	250-74-11	230123-6	41mm*	644-712	475-525 Lb.Ft.
SPL170	250-74-11	230123-6	41mm*	644-712	475-525 Lb.Ft.
SPL250	250-74-11	230123-6	41mm*	644-712	475-525 Lb.Ft.

** A 1 5/8" socket may be used.*

Table DD

Remove Midship Nut on Center Bearing Yoke

13. Remove midship nut. Reference midship nut specifications Table DD, above. (See photo 84, below.) Discard nut. If washer is damaged, discard and replace. Otherwise, reuse washer. ▲ See warning, below.

▲ ***WARNING***

DO NOT *reuse midship nut. Reuse of midship nut can cause driveline failure, which can result in separation of driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.*

Photo 84

Photo 85

Mark Center Bearing End Yoke Counterbore

Caution – The following step is an additional marking process to that described in step one. Be sure to mark as directed.

14. Mark the counterbore of end yoke to midship "nose" with marking stick, paint marker or other legible marking device. This assures proper reassembly of the center bearing end yoke in its original phased position. (See photo 85, above.) ▲ See warning, below.

▲ ***WARNING***

Reassembly of a driveline out of original phase can cause vibration and failure of the driveline and attaching components. Failure of a driveline can result in separation of driveline from the vehicle, which can result in property damage, serious personal injury or death.

Disconnect Coupling Shaft With Effected Center Bearing

15. Remove center bearing bracket bolts. (See photo 86, page 99.) Allow coupling shaft to rest on support strap.

Remove Coupling Shaft With Effected Center Bearing

16. Remove bearing retainers or stamped straps and bolts from end yoke. Discard bolts and stamped straps. ▲ See warning, below.

▲ ***WARNING***

DO NOT *reuse bearing retainer bolts, stamped straps, stamped strap bolts, damaged bearing retainers or use inferior grade bolts. Reuse of bearing retainer bolts, stamped straps, stamped strap bolts, damaged bearing retainers or the use of inferior grade bolts can cause driveline failure, which can result in separation of driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.*

17. It may be necessary to unseat bearing cup assemblies by tapping on yoke or bearing cup with a soft-faced hammer. Once the coupling shaft is free, remove from support straps and take it to a work bench area. ▲ See warning, below.

▲ ***WARNING***

Driveshaft assemblies can weigh in excess of 100 pounds (46 kilograms). Make sure to use proper lifting techniques when handling driveshafts. More than one person may be needed when handling driveshaft assemblies.

Remove Center Bearing End Yoke

18. Using a puller, follow the tool manufacturer's instructions to remove the Quick Disconnect™ yoke. (See photo 87, center right.) The yoke has a press fit and should **NOT** be removed with a hammer. If the yoke is loose enough to be removed by hand, the entire coupling shaft must be replaced. Remove and discard slinger from the yoke. ▲ See warning, below.

▲ ***WARNING***

Failure to replace damaged driveline components can cause driveline failure, which can result in separation of driveline from vehicle. A separated driveline can result in property damage, serious personal injury or death.

Photo 86

Photo 87

Inspect Center Bearing End Yoke Splines

19. Visually inspect the splines of the center bearing end yoke. If the yoke splines are damaged, missing or twisted, the yoke must be replaced. If the yoke hub is cracked, the yoke must be replaced ▲ See warning, step 18.

Inspect Midship

20. Visually inspect the midship splines and threads. If the splines or threads are damaged, missing or twisted, replacement of the entire coupling shaft is necessary. ▲ See warning, step 18.

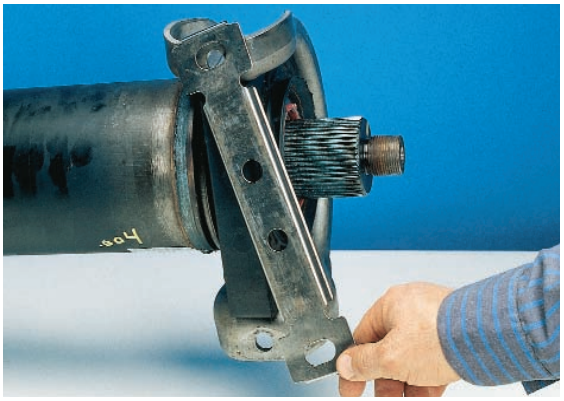


Photo 88

Photo 89

Remove Center Bearing

21. On some Spicer center bearing assemblies, a metal retainer spans the outside center bearing bracket. If present, remove metal retainer and discard. (See photo 88, above.)

22. Remove and discard center bearing bracket. (See photo 89, top right.) Remove and discard rubber cushion. (See photo 90, right.)

Photo 90

23. Using a puller, follow the tool manufacturer's instructions to remove the bearing assembly from the midship. (See photo 91, right.) Discard the center bearing.

Inspect Midship Bearing Diameter

24. Inspect midship for wear on the bearing diameter. If the midship is damaged from a seized bearing, replacement of the entire coupling shaft is necessary. (See photo 92, right.) ▲ See warning, below.

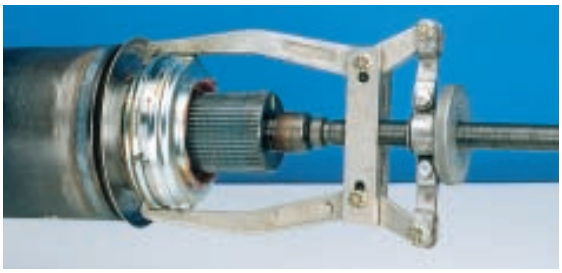


Photo 91

▲ ***WARNING***

Failure to replace damaged driveline components can cause driveline failure, which can result in separation of driveline from vehicle. A separated driveline can result in property damage, serious personal injury or death.

Photo 92

25. If no damage is apparent, remove slinger and proceed to installation of center bearing, Quick Disconnect™ Yoke Style, pages 128 to 132.

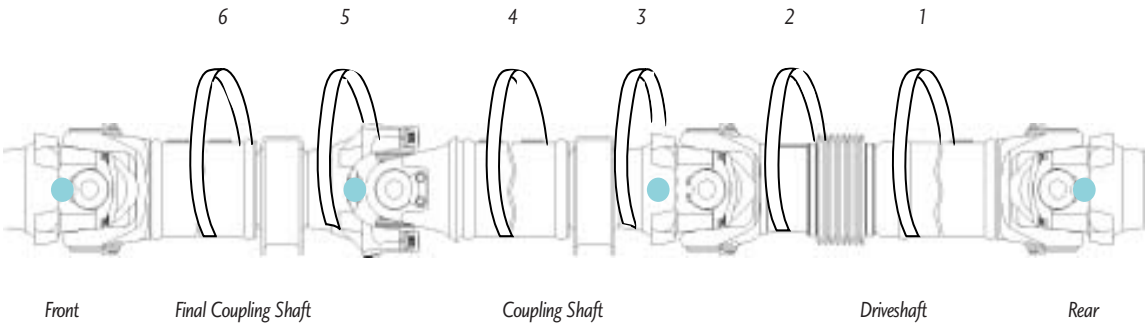


Figure W, S.A.E.

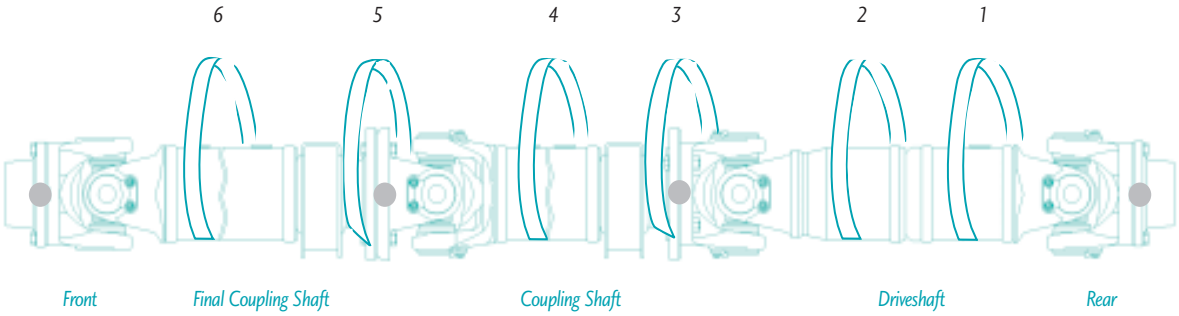


Figure X, DIN and T-Type

COMPANION FLANGE/FLANGE YOKE (S.A.E., DIN AND T-TYPE STYLE)

Caution – Be sure to carefully read all information on page 39 before proceeding.

Note – When working with multiple-piece driveshafts, it may be necessary to remove the entire driveline assembly. Work from the **rear** end forward. The driveshaft will need to be disconnected in order to allow clearance for the removal of any coupling shaft. Work on only one connection at a time. Be sure to properly position support straps.

Mark Driveshaft ("Phasing Marks")

1. It is imperative to mark all mating components of the driveshaft, as illustrated in Figure W or X, above. Mark the driveshaft with a marking stick, paint marker or other legible marking device. In addition, be sure to mark all flange positions, spline positions, and shaft locations. This assures proper reassembly of the driveshaft into the vehicle, in its original position. ▲ See warning, below.

▲ ***WARNING***

Reassembly of a driveline out of original phase can cause vibration and failure of the driveline and attaching components. Failure of a driveline can result in separation of driveline from the vehicle, which can result in property damage, serious personal injury or death.

Position Support Straps

2. Working from the **rear** end forward, position support straps 1 through 6 (as needed) as illustrated in Figure W or X, above. ▲ See warning, below.

▲ ***WARNING***

***ALWAYS** use support straps to prevent driveshaft from falling out of vehicle. Failure to use support straps can cause damage to driveshaft or result in property damage, serious personal injury or death.*

COMPANION FLANGE/FLANGE YOKE STYLE (S.A.E., DIN AND T-TYPE) HARDWARE SPECIFICATIONS

SERIES	BOLT P/N*†	WASHER P/N	NUT P/N	DIAMETER, THREAD & LENGTH UNDER HEAD	BOLT TORQUE Nm	BOLT TORQUE FT. LBS.
SPL55	TBD	TBD	TBD	TBD	TBD	TBD
SPL70	TBD	TBD	TBD	TBD	TBD	TBD
SPL90	6-73-1219	500357-11	231421-3	.375" 24 x 1.188"	54-65	40-48
SPL100	TBD	TBD	TBD	TBD	TBD	TBD
SPL140	6-73-220	500357-11	231421-3	.375" 24 x 1.250"	54-65	40-48
	6-73-1227	500357-11	231421-3	.375" 24 x 1.688"	54-65	40-48
SPL170	7-73-122	500357-12	231421-4	.438" 20 x 1.375"	85-102	63-75
	7-73-228	500357-12	231421-4	.438" 20 x 1.750"	85-102	63-75
SPL250	7-73-122	500357-12	231421-4	.438" 20 x 1.375"	85-102	63-75
	7-73-228	500357-12	231421-4	.438" 20 x 1.750"	85-102	63-75

**Bolts are specially heat-treated. DO NOT substitute inferior grade bolts.*

† Approved Spicer hardware.

***Note**-Original equipment vehicle manufacturers' manuals may have alternate specified bolts or metric hardware. Refer to the original equipment service manual for bolt part numbers.*

Table EE

Attach support straps to frame rails or some structural part of the vehicle. **DO NOT** attach support straps to gas lines, oil lines, brake lines, or wiring. **DO NOT** entangle gas lines, oil lines, brake lines, or wiring in support straps. See warning, below.

WARNING

Attaching or entangling support straps to fuel, oil or brake lines or wiring can result in their damage. Damaged fuel, oil or brake lines or wiring can result in failure of the vehicle, which can result in property damage, serious personal injury or death.

Disconnect Driveshaft

3. With support straps securely in place, disconnect the driveshaft from the coupling shaft by removing the companion flange bolts. Reference hardware specifications, Table EE, above. **DO NOT** reuse companion flange bolts, washers or nuts. See warning, top right. Allow driveshaft to rest on the support straps.

WARNING

***DO NOT** reuse companion flange bolts, washers or nuts or use inferior grade bolts. Reuse of companion flange bolts, washers or nuts or the use of inferior grade bolts can cause driveline failure, which can result in separation of the driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.*

4. It may be necessary to unseat pilot or serrated connection by tapping on one side of the flange with a soft-faced hammer. Once the connection is free, collapse the driveshaft and allow it to rest on support strap.

If disconnecting the driveshaft has allowed access to the effected center bearing, proceed to step 9. **DO NOT** at this point remove coupling shaft with the effected center bearing from the vehicle.

If the effected center bearing has not been reached, proceed to step 5 to remove coupling shaft(s) to reach coupling shaft with effected center bearing.

Photo 93

Disconnect Coupling Shaft

5. **Be sure the third support strap is in place as illustrated in Figure W or X, page 101.** Remove the center bearing bracket bolts and allow the shaft to rest on the support strap. (See photo 93, above.)

Remove Coupling Shaft

6. **Be sure the fourth support strap is in place as illustrated in Figure W or X, page 101.** Remove companion flange, bolts, washers and nuts. Reference hardware specifications, Table EE, page 102. Discard companion flange bolts, washers and nuts. ▲ See warning, below.

▲ ***WARNING***

DO NOT *reuse companion flange bolts, washers or nuts, or use inferior grade bolts. Reuse of companion flange bolts, washers or nuts, or the use of inferior grade bolts can cause driveline failure, which can result in separation of driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.*

7. It may be necessary to unseat pilot or serrated connection by tapping on one side of the flange with a soft-faced hammer. Once coupling shaft is free, remove the coupling shaft from support straps and take to a work bench area. ▲ See warning, below.

▲ ***WARNING***

Driveshaft assemblies can weigh in excess of 100 pounds (46 kilograms). Make sure to use proper lifting techniques when handling driveshafts. More than one person may be needed when handling driveshaft assemblies.

8. Repeat steps 5-7 as necessary to obtain access to the effected center bearing. **DO NOT** at this point remove coupling shaft, with the effected center bearing, from the vehicle.

Inspect Center Bearing Flange

9. Inspect all flange faces for galling or damage. If damaged, the flange must be replaced. ▲ See warning, step 10.

10. Visually inspect the center bearing flange. Check the flange for looseness, backlash and broken back. Take hold of center bearing flange with both hands. Try to move it vertically and horizontally to feel any looseness. There should **NOT** be any movement. If any of these conditions are present, the entire shaft must be replaced. ▲ See warning, below.

▲ ***WARNING***

Failure to replace damaged driveline components can cause driveline failure, which can result in separation of driveline from vehicle. A separated driveline can result in property damage, serious personal injury or death.

Note – If effected center bearing was in the final coupling shaft, repeat the same inspection steps on front flange prior to reinstallation of final coupling shaft into vehicle.

MIDSHIP NUT SPECIFICATIONS

SERIES	NUT P/N	WASHER P/N	HEAD SIZE	NUT TORQUE Nm	NUT TORQUE LB. FT.
SPL55	TBD	TBD	TBD	TBD	TBD
SPL70	TBD	TBD	TBD	TBD	TBD
SPL90	231502	N/A	1 5/8"	644-712	475-525 Lb.Ft.
SPL100	TBD	TBD	TBD	TBD	TBD
SPL140	250-74-11	230123-6	41mm*	644-712	475-525 Lb.Ft.
SPL170	250-74-11	230123-6	41mm*	644-712	475-525 Lb.Ft.
SPL250	250-74-11	230123-6	41mm*	644-712	475-525 Lb.Ft.

** A 1 5/8" socket may be used.*

Table FF

Remove Midship Nut on Center Bearing Flange

11. Remove and discard midship nut. Reference midship nut specifications, Table FF, above. If washer is damaged, discard and replace. Otherwise, reuse washer. See warning, below.

WARNING

DO NOT *reuse midship nut. Reuse of midship nut can cause driveline failure, which can result in separation of driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.*

Mark Center Bearing Flange Counterbore

Caution – The following step is an additional marking process to that described in step 1. Be sure to mark as directed.

12. Mark the counterbore of the companion flange to midship "nose" with a marking stick, paint marker or other legible marking device. This assures proper reassembly of the companion flange in its original phased position. See warning, below.

WARNING

Reassembly of a driveline out of original phase can cause vibration and failure of the driveline and attaching components. Failure of a driveline can result in separation of driveline from the vehicle, which can result in property damage, serious personal injury or death.

Disconnect Coupling Shaft With Effected Center Bearing

13. Remove center bearing bracket bolts and allow shaft to rest on support strap.

Remove Coupling Shaft With Effected Center Bearing

14. Remove and discard flange bolts, washers and nuts at end fitting. See warning, below.

WARNING

DO NOT *reuse flange bolts, washers or nuts or use inferior grade bolts. Reuse of flange bolts, washers or nuts or the use of inferior grade bolts can cause driveline failure, which can result in separation of driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.*

15. It may be necessary to unseat pilot or serrated connection by tapping on one side of the flange with a soft-faced hammer. Once the connection is free, remove coupling shaft from support straps and take it to a work bench area. See warning, below.

WARNING

Driveshaft assemblies can weigh in excess of 100 pounds (46 kilograms). Make sure to use proper lifting techniques when handling driveshafts. More than one person may be needed when handling driveshaft assemblies.

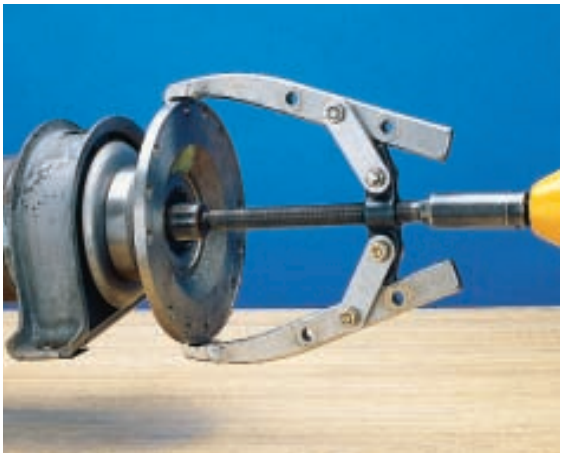


Photo 94

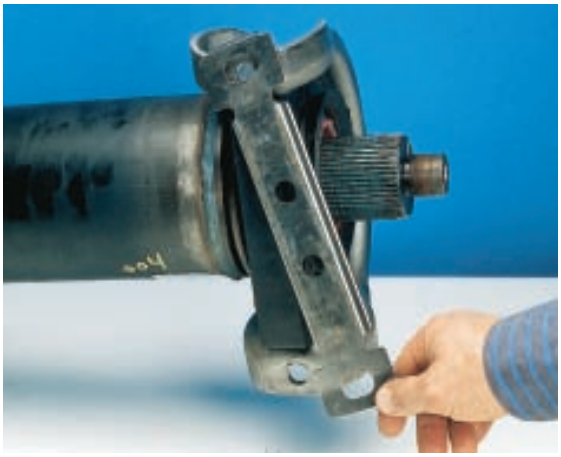


Photo 95

Remove Center Bearing Companion Flange

16. Using a puller, follow the tool manufacturer's instructions to remove the center bearing companion flange. (See photo 94, above.) Flange has a press fit and should **NOT** be removed with a hammer. If flange is loose enough to be removed by hand, the entire coupling shaft should be replaced. ▲ See warning, below. Remove and discard the slinger from the flange.

▲ ***WARNING***

Failure to replace damaged driveline components can cause driveline failure, which can result in separation of driveline from vehicle. A separated driveline can result in property damage, serious personal injury or death.

Inspect Center Bearing Flange

17. Visually inspect the center bearing companion flange splines and bolt hole threads or through holes. If the splines are damaged, missing or twisted, the entire coupling shaft should be replaced. If the center bearing flange hub is cracked, the pilots have damage or burrs, or bolt hole threads or through holes are damaged, replace the center bearing flange. ▲ See warning, step 16.

Inspect Midship

18. Visually inspect the midship splines and threads. If splines or threads are damaged, missing or twisted, replacement of the entire coupling shaft is necessary. ▲ See warning, below.

▲ ***WARNING***

Failure to replace damaged driveline components can cause driveline failure, which can result in separation of driveline from vehicle. A separated driveline can result in property damage, serious personal injury or death.

Remove Center Bearing

19. On some Spicer center bearing assemblies, a metal retainer spans the outside center bearing bracket. If present, remove the metal retainer and discard. (See photo 95, above.)

Photo 96

Photo 97

Remove and discard the center bearing bracket. (See photo 96, above.) Remove and discard the rubber cushion. (See photo 97, top right.)

20. Using a puller, follow the tool manufacturer's instructions to remove the bearing assembly from the midship. (See photo 98, center right.) Discard the center bearing.

Inspect Midship Bearing Diameter

21. Inspect midship for wear on bearing diameter. If midship is damaged from a seized bearing, replacement of entire coupling shaft is necessary. (See photo 99, bottom right.) ▲ See warning, below.

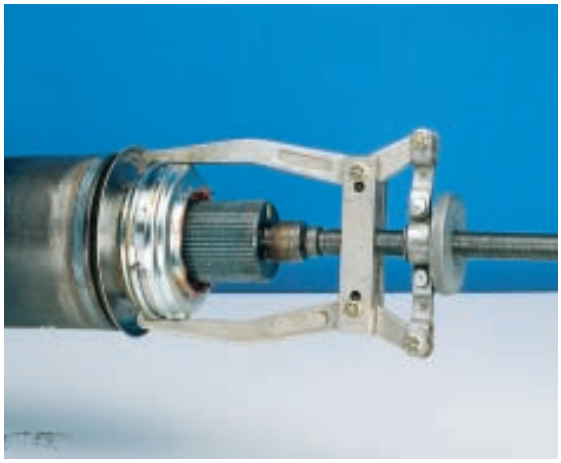


Photo 98

▲ ***WARNING***

Failure to replace damaged driveline components can cause driveline failure, which can result in separation of driveline from vehicle. A separated driveline can result in property damage, serious personal injury or death.

22. If no damage is apparent, remove slinger and discard. Proceed to installation of center bearing companion flange/ flange yoke (S.A.E., DIN and T-Type) style, pages 128 to 132.

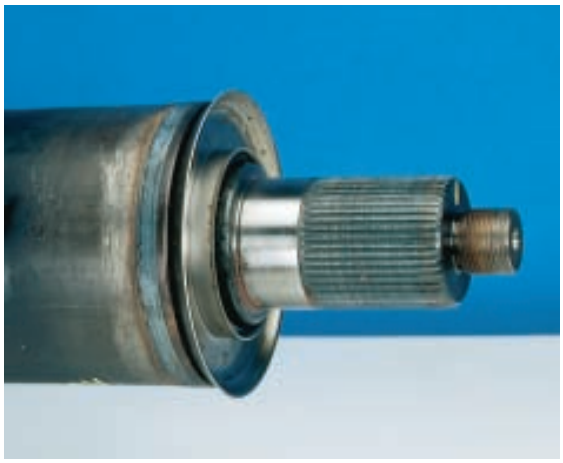


Photo 99

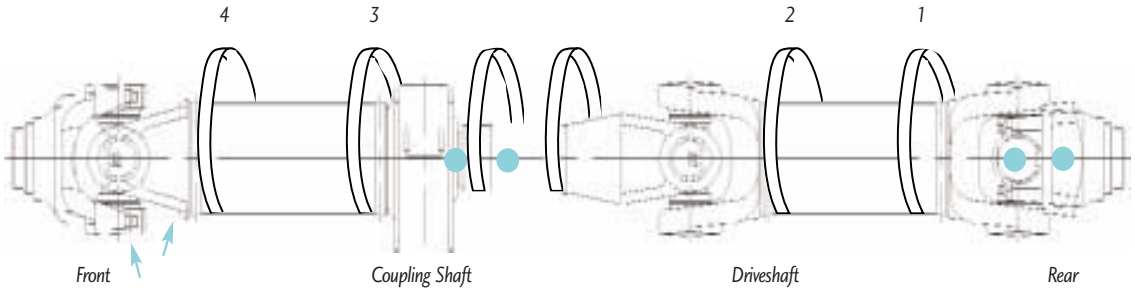


Figure Y, Quick Disconnect

OUTBOARD SLIP STYLE SPICER LIFE SERIES 55, 70, 90 & 100

Caution – Be sure to carefully read all information on page 39 before proceeding.

Note – When working with multiple-piece driveshafts, it may be necessary to remove the entire driveline assembly. Work from **rear** end forward. The driveshaft will need to be disconnected **first** in order to allow clearance for the removal of any coupling shaft. Work on only one connection at a time. Be sure to properly position support straps.

Mark Driveshaft ("Phasing Marks")

1. It is imperative to mark all mating components of a driveshaft, as illustrated in Figure Y above. Mark driveshaft with a marking stick, paint marker or other legible marking device.

Quick Disconnect™ Style

Be sure to mark all bearing positions, spline positions, shaft locations, bearing retainers (if applicable) and stamped straps.

Companion Flange/Flange Yoke (S.A.E., DIN and T-Type) Style

Be sure to mark all flange positions, spline positions and shaft locations.

This assures proper reassembly of the driveshaft into the vehicle, in its original position. ▲ See warning, below.

▲ ***WARNING***

Reassembly of a driveline out of original phase can cause vibration and failure of the driveline and attaching components. Failure of a driveline can result in separation of driveline from the vehicle, which can result in property damage, serious personal injury or death.

Position Support Straps

2. Working from the **rear** end forward, position support straps 1 through 4 (as needed) as illustrated in Figure Y, above. ▲ See warning, below.

▲ ***WARNING***

***ALWAYS** use support straps to prevent driveshaft from falling out of vehicle. Failure to use support straps can cause damage to driveshaft or result in property damage, serious personal injury or death.*

Attach support straps to frame rails or some structural part of the vehicle. **DO NOT** attach support strap to gas lines, oil lines, brake lines, or wiring. **DO NOT** entangle gas lines, oil lines, brake lines, or wiring in support strap. ▲ See warning, below.

▲ ***WARNING***

Attaching or entangling support straps to fuel, oil or brake lines or wiring can result in their damage. Damaged fuel, oil or brake lines or wiring can result in failure of the vehicle, which can result in property damage, serious personal injury or death.

Quick Disconnect™ Style

Proceed to step 3.

Companion Flange/Flange Yoke Style (S.A.E., DIN and T-Type) Style Proceed to step 10.

QUICK DISCONNECT™ BOLT SPECIFICATIONS

SERIES	BOLT P/N*	THREAD SIZE	HEAD SIZE	BOLT TORQUE Nm	BOLT TORQUE LB. FT.
SPL55	TBD	TBD	TBD	TBD	TBD
SPL70	TBD	TBD	TBD	TBD	TBD
SPL90	6-73-412	0.375 in. - 24	3/8 in., 12 point	61-81	45-60
SPL100	TBD	TBD	TBD	TBD	TBD
SPL140	12-73-125M	12mm - 1.25	12 mm, 12 point	135-160	100-120
SPL170	12-73-125M	12mm - 1.25	12 mm, 12 point	135-160	100-120
SPL250	12-73-125M	12mm - 1.25	12 mm, 12 point	135-160	100-120

** Bolts are specially heat-treated.*
DO NOT substitute with inferior grade bolts.

Table GG

Disconnect Driveshaft Quick Disconnect™ Style

3. With support straps securely in place, remove bearing retainers or stamped straps and bolts at **rear** end. Reference bolt specifications, Table GG, above. If bearing retainers are not damaged, they can be reused. **DO NOT** reuse stamped straps or any bolts. See warning, below.

WARNING

DO NOT *reuse bearing retainer or stamped strap bolts, stamped straps, damaged bearing retainers or use inferior grade bolts. Reuse of bearing retainer or stamped strap bolts, stamped straps, damaged bearing retainers or use of inferior grade bolts can cause driveline failure, which can result in separation of the driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.*

4. It may be necessary to unseat bearing cup assemblies by tapping on yoke or bearing cup with a soft-faced hammer. Once the bearing cup assemblies are free, collapse the driveshaft until both bearing assemblies clear the open yoke cross holes. Allow driveshaft to rest on support strap.

Remove Driveshaft

5. Slide driveshaft off of outboard midship tube shaft at slip yoke. Remove driveshaft from vehicle and take to work bench area. See warning, below.

WARNING

Driveshaft assemblies can weigh in excess of 100 pounds *(46 kilograms)*. Make sure to use proper lifting techniques when handling driveshafts. More than one person may be needed when handling driveshaft assemblies.

If disconnecting the driveshaft has allowed access to the effected center bearing, proceed to step 17.

If the effected center bearing has not been reached, proceed to step 6 to remove coupling shaft(s).

Disconnect Coupling Shaft

6. **Be sure the third support strap is in place as illustrated in Figure Y, page 107.** Remove the center bearing bracket bolts and allow the shaft to rest on the support strap.

Remove Coupling Shaft

7. **Be sure the fourth support strap is in place as illustrated in Figure Y, page 107.** Remove bearing retainers or stamped straps and bolts on end yoke. Reference bolt specifications, Table GG, top left. Discard bolts. Discard stamped straps (if applicable). See warning, step 3.

COMPANION FLANGE/FLANGE YOKE STYLE (S.A.E., DIN AND T-TYPE) HARDWARE SPECIFICATIONS

SERIES	BOLT P/N*†	WASHER P/N	NUT P/N	DIAMETER, THREAD & LENGTH UNDER HEAD	BOLT TORQUE Nm	BOLT TORQUE FT. LBS.
SPL55	TBD	TBD	TBD	TBD	TBD	TBD
SPL70	TBD	TBD	TBD	TBD	TBD	TBD
SPL90	6-73-1219	500357-11	231421-3	.375" 24 x 1.188"	54-65	40-48
SPL100	TBD	TBD	TBD	TBD	TBD	TBD
SPL140	6-73-220	500357-11	231421-3	.375" 24 x 1.250"	54-65	40-48
	6-73-1227	500357-11	231421-3	.375" 24 x 1.688"	54-65	40-48
SPL170	7-73-122	500357-12	231421-4	.438" 20 x 1.375"	85-102	63-75
	7-73-228	500357-12	231421-4	.438" 20 x 1.750"	85-102	63-75
SPL250	7-73-122	500357-12	231421-4	.438" 20 x 1.375"	85-102	63-75
	7-73-228	500357-12	231421-4	.438" 20 x 1.750"	85-102	63-75

**Bolts are specially heat-treated. DO NOT substitute inferior grade bolts.*
† Approved Spicer Hardware.
***Note**-Original equipment vehicle manufacturers' manuals may have alternate specified bolts or metric hardware. Refer to the original equipment service manual for bolt part numbers.*

Table HH

8. It may be necessary to unseat bearing cup assemblies by tapping on yoke or bearing cup with a soft-faced hammer. Once coupling shaft is free, remove the coupling shaft from support straps and take it to a work bench area. ▲ See warning, below.

▲ ***WARNING***

Driveshaft assemblies can weigh in excess of 100 pounds (46 kilograms). Make sure to use proper lifting techniques when handling driveshafts. More than one person may be needed when handling driveshaft assemblies.

9. Repeat steps 6-8 as necessary to obtain access to the effected center bearing, once the effected centering bearing has been reached. **DO NOT** at this point remove coupling shaft from vehicle. It will be necessary to continue with pages 98-100, steps 13 to 25, for Quick Disconnect™ style.

Disconnect Driveshaft – Companion Flange/Flange Yoke (S.A.E., DIN and T-Type) Style

10. With support straps securely in place, remove and discard companion flange bolts, washers and nuts from rear end. Reference companion flange bolt torque specifications, Table HH, above. **DO NOT** reuse companion flange bolts, washers and nuts. ▲ See warning, below.

▲ ***WARNING***

***DO NOT** reuse companion flange bolts, washers or nuts or use inferior grade bolts. Reuse of companion flange bolts, washers or nuts or the use of inferior grade bolts can cause driveline failure, which can result in separation of the driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.*

11. It may be necessary to unseat pilot or serrated connection by tapping on one side of the flange with a soft-faced hammer. Once the connection is free, collapse the driveshaft and allow it to rest on support strap.

Remove Driveshaft

12. Slide driveshaft off outboard midship shaft at slip yoke. Remove driveshaft from vehicle and take to work bench area. See warning, below.

WARNING

Driveshaft assemblies can weigh in excess of 100 pounds (46 kilograms). Make sure to use proper lifting techniques when handling driveshafts. More than one person may be needed when handling driveshaft assemblies.

If disconnecting the driveshaft has allowed access to the effected center bearing, proceed to step 17.

If the effected center bearing has not been reached, proceed to step 13 to remove coupling shaft(s).

Disconnect Coupling Shaft

13. **Be sure the third support strap is in place as illustrated in Figure Y, page 107.** Remove the center bearing bracket bolts and allow the shaft to rest on the support strap.

Remove Coupling Shaft

14. **Be sure the fourth support strap is in place as illustrated in Figure Y, page 107.** Remove companion flange bolts, washers and nuts on flange. Reference bolt specifications, Table HH, page 109. Discard bolts, washers and nuts. See warning, below.

WARNING

***DO NOT** reuse companion flange bolts, washers or nuts, or use inferior grade bolts. Reuse of companion flange bolts, washers or nuts, or the use of inferior grade bolts can cause driveline failure, which can result in separation of driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.*

15. It may be necessary to unseat pilot or serrated connection by tapping on one side of the flange with a soft-faced hammer. Once coupling shaft is free, remove the coupling shaft from support straps and take to a work bench area. See warning, step 12.

16. Repeat steps 13-15 as necessary to obtain access to the effected center bearing. Once the effected center bearing has been reached, **DO NOT** now remove coupling shaft from vehicle.

At this point it will be necessary to continue with pages 104-106, steps 11-22, for companion flanger/flanger yoke style.

Inspect Midship Tube Shaft

17. Visually inspect midship tube shaft, looking for wear on spline surface. If splines are damaged, missing or twisted, or Glidecote® is missing, replacement of entire coupling shaft is necessary. See warning, below.

WARNING

Failure to replace damaged driveline components can cause driveline failure, which can result in separation of driveline from vehicle. A separated driveline can result in property damage, serious personal injury or death.

Remove Coupling Shaft With Effected Center Bearing – Quick Disconnect Style

Proceed to step 18.

Remove Coupling Shaft With Effected Center Bearing – Companion Flange/Flange Yoke (S.A.E., DIN and T-Type) Style

Proceed to step 20.

Quick Disconnect™ Style

18. Remove center bearing bracket bolts. Allow coupling shaft to rest on support strap.

Remove bearing retainers or stamped straps and bolts at end yoke. Discard bolts. If bearing retainers are not damaged, they **CAN** be reused. **DO NOT** reuse stamped straps or any bolts. ▲ See warning, below.

▲ ***WARNING***

DO NOT *reuse bearing retainer or stamped strap bolts, stamped straps, damaged bearing retainers, or use inferior grade bolts. Reuse of bearing retainer or stamped strap bolts, stamped straps, damaged bearing retainers, or the use of inferior grade bolts can cause driveline failure, which can result in separation of driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.*

19. It may be necessary to unseat bearing cup assemblies by tapping on yoke or bearing cup with a soft-faced hammer. Once the coupling shaft is free, remove from support straps and take it to a work bench area. ▲ See warning, below. Proceed to step 22.

▲ ***WARNING***

Driveshaft assemblies can weigh in excess of 100 pounds (46 kilograms). Make sure to use proper lifting techniques when handling driveshafts. More than one person may be needed when handling driveshaft assemblies.

Companion Flange/Flange Yoke (S.A.E., DIN and T-Type) Style

20. Remove center bearing bracket bolts and allow shaft to rest on support strap.

Remove and discard flange bolts, washers and nuts at flange. ▲ See warning, below.

▲ ***WARNING***

DO NOT *reuse flange bolts, washers or nuts or use inferior grade bolts. Reuse of flange bolts, washers or nuts or the use of inferior grade bolts can cause driveline failure, which can result in separation of driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.*

21. It may be necessary to unseat pilot or serrated connection by tapping on one side of the flange with a soft-faced hammer. Once the connection is free, remove coupling shaft from support straps and take it to a work bench area. ▲ See warning, step 19. Proceed to step 22.

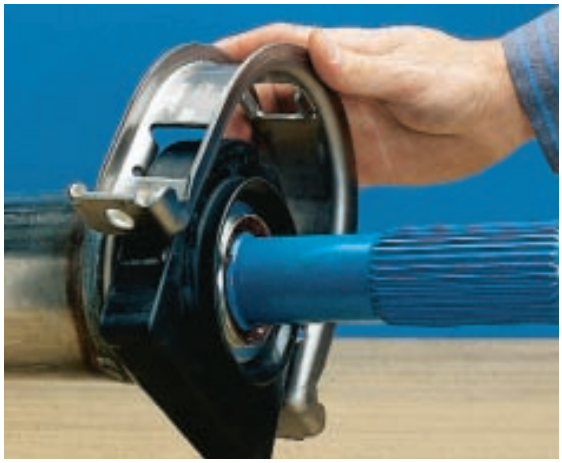


Photo 100

Photo 101

Remove Center Bearing

22. On some Spicer center bearing assemblies, a metal retainer spans the outside center bearing bracket. If present, remove metal retainer and discard. Remove and discard center bearing bracket. (See photo 100, above.) Remove and discard rubber cushion. (See photo 101, top right.)

23. Using a puller, follow tool manufacturer's instructions to remove the bearing assembly from the midship tube shaft. (See photo 102, center right.) Discard center bearing.

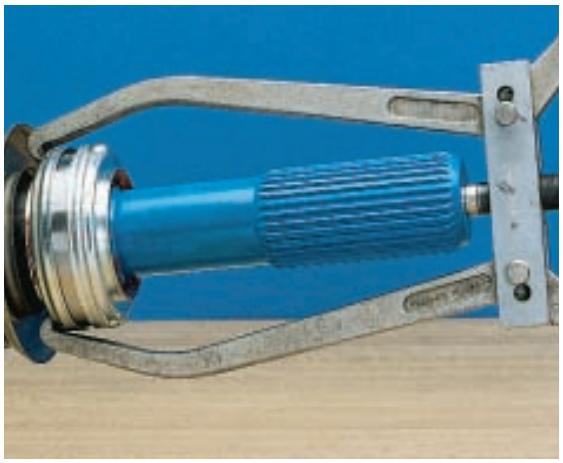


Photo 102

Inspect Midship Tube Shaft Bearing Diameter

24. Inspect the midship tube shaft for wear on the bearing diameter. If the midship tube shaft is damaged, replacement of the entire coupling shaft is necessary. (See photo 103, bottom right.) ▲ See warning, below.

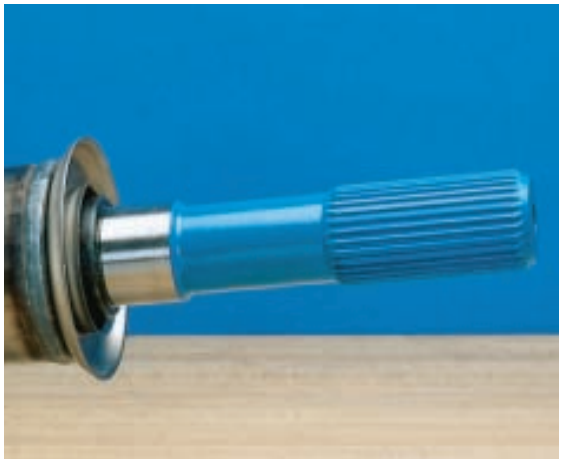


Photo 103

▲ ***WARNING***

Failure to replace damaged driveline components can cause driveline failure, which can result in separation of driveline from vehicle. A separated driveline can result in property damage, serious personal injury or death.

25. If no damage is apparent, remove slinger and discard. Proceed to installation of center bearing outboard slip style driveshafts, pages 128-132.

TABLE OF CONTENTS

SPICER LIFE SERIES™ INSPECTION

Before You Get Started

Note – Spicer Life Series™ driveshafts are found on vehicles throughout the world. Therefore, this manual includes worldwide terminology. These terms have been highlighted in teal.

Caution – Under no circumstances should individuals attempt to perform driveline service and/or maintenance procedures for which they have not been trained or do not have the proper tools and equipment. ▲ See warning, below.

▲ ***WARNING***

Failure to take commonsense, precautionary measures when working on a vehicle or other machinery could result in property damage, serious personal injury or death. In order to avoid property damage, serious personal injury or death, you must:

1. **ALWAYS** wear safety glasses when performing maintenance or service. Failure to wear safety glasses can result in personal injury and/or partial or complete vision loss.

2. **NEVER** go under a vehicle while the engine is running. Be sure the vehicle's engine is off, and keys are removed from ignition.

3. **NEVER** go under or work on a vehicle that is not on a level or flat surface.

4. **NEVER** work on a driveshaft without blocking the vehicle's wheels and releasing all parking brakes. ▲ See warning, below.

▲ ***WARNING***

Failure to release all parking brakes and failure to place transmission in neutral can result in torque being applied to the driveshaft. Disconnecting a driveshaft with applied torque can result in property damage, serious personal injury or death.

5. **NEVER** lift a vehicle without the appropriate weight-rated, vehicle-support equipment.

6. **NEVER REMOVE** a driveshaft from the vehicle without keeping the vehicle's transmission in neutral. ▲ See warning, step 4.

7. **CAUTION** – Spicer Life Series™ driveshaft assemblies can weigh in excess of 100 pounds (46 kilograms). Be sure to use proper lifting techniques when handling Spicer Life Series™ driveshafts. More than one person may be needed when handling driveshaft assemblies.

8. **ALWAYS** use support straps to prevent the driveshaft from falling out of vehicle during the removal and installation process.

9. **NEVER** heat components or use sledgehammers or floor jacks to remove the driveshaft from vehicle.

Note – For driveshaft applications that have pillow blocks, dampers, parking brakes or retarders, refer to these component manufacturers' or the original equipment vehicle manufacturers' service manuals for proper procedures.

Note – Spicer Life Series™ 140, 170 and 250 driveshaft assemblies and components are metric. To eliminate any confusion between S.A.E. and metric threaded fasteners, the metric fasteners have been color coded gold. Spicer Life metric fasteners include spring tab bolts, bearing retainer bolts and midship nuts.

DRIVESHAFT ASSEMBLY INSPECTION PROCEDURES

SPICER LIFE SERIES™ 55, 70, 90, 100, 140, 170 & 250

Spicer Life Series™ driveshafts should be carefully inspected at recommended original equipment vehicle manufacturers' service intervals and/or at Spicer recommended lubrication intervals as shown in Table A, below.

Note – The following procedures are to be performed **prior to** any lubrication of universal joints or slip members. The addition of lubricant can mask the looseness in a component that is beginning to show wear and may be in need of replacement.

END FITTINGS

1. Visually inspect all input and output end-fitting retaining nuts or bolts for any gaps between mating surfaces. If gaps are present, consult transmission, axle or transfer case original equipment manufacturers' service and maintenance manuals for proper fastener specifications. ▲ See warning, below.

▲ ***WARNING***

A loose end-fitting retaining nut or bolt can result in driveline failure, which can result in separation of the driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.

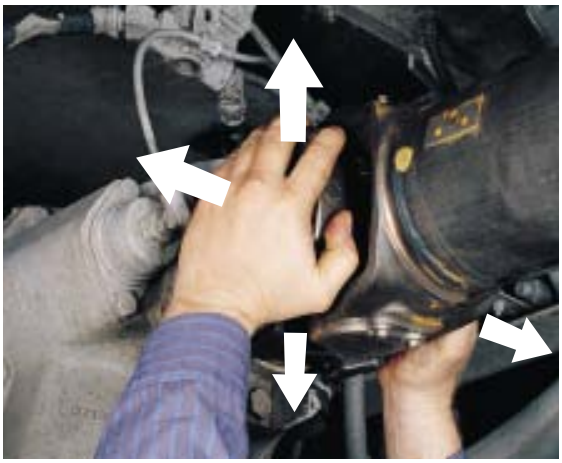


Photo 1

2. Check all input and output end fittings for looseness or broken back. Take hold of the end fitting with both hands. Try to move it vertically and horizontally to feel any looseness. (See photo 1, above.)

There should **NOT** be any movement in the end fittings

UNIVERSAL JOINT MAXIMUM LUBRICATION INTERVALS

SERIES	CITY	ON-HWY.	LINEHAUL	OFF-HWY.*	INDUSTRIAL*
SPL 250, 170 & 140	25,000 Mi. 40,000 Km. or 3 Months (whichever comes first)	100,000 Mi. 160,000 Km. or 6 Months (whichever comes first)	100,000 Mi. 160,000 Km. or 6 Months (whichever comes first)	25,000 Mi. 40,000 Km. or 3 Months (whichever comes first)	500 Hrs.
SPL 100, 90, 70 & 55	8,000 Mi. 12,800 Km. or 3 Months (whichever comes first)	15,000 Mi. 24,000 Km. or 3 Months (whichever comes first)	15,000 Mi. 24,000 Km. or 3 Months (whichever comes first)	8,000 Mi. 12,800 Km. or 3 Months (whichever comes first)	500 Hrs.

City *is defined as all applications that require a minimum of 90% of operation time within city limits.*

On-highway *is defined as all applications requiring less than 10% of operating time on gravel, dirt or unpaved roads.*

Off-highway *is defined as all applications requiring more than 10% of operating time on gravel, dirt or unpaved roads.*

Linehaul *is defined as 100% of operation time on smooth concrete or asphalt.*

** Relubrication intervals for off-highway and industrial use vary depending on the application and operating conditions. In general, to obtain maximum life, relubrication on industrial applications should occur every 500 hours for normal service and every 250 hours for continuous service or severe environmental conditions.*

Table A

relative to the output or input shafts to which they are connected. ▲ See warning, below.

▲ ***WARNING***

A loose end fitting can result in driveline failure, which can result in separation of the driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.

If looseness is evident, consult transmission, axle or transfer case original equipment manufacturers' service and maintenance manuals for proper end fitting specifications.

3. If the end fittings are tight, check for excessive radial looseness of the transmission output shaft and axle input and output shaft splines relative to the end fitting.

Take hold of the end fitting with both hands, rotate left to right, feeling for play or backlash. If radial looseness is evident, end fittings or input or output shafts may be in need of replacement. (See photo 2, below.) ▲ See warning, below.

▲ ***WARNING***

A loose end fitting, due to transmission or axle input and/or output shaft spline wear or end fitting spline wear, can result in driveline failure. Driveline failure can result in separation of the driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.

Photo 2

4. Visually inspect for damaged bearing retainers or stamped straps, loose bearing retainer bolts or strap bolts, loose companion flange bolts and nuts, loose or missing spring tabs or spring tab bolts, damaged tangs on end fittings, damaged or missing snap rings, and rotating bearing cups. ▲ See warning, below.

If any of these situations are evident, replacement of the components is necessary. Refer to the removal and installation sections of this manual for proper replacement procedures.

▲ ***WARNING***

Loose, missing or damaged bearing retainers or stamped straps, retaining nuts, bolts, spring tabs or spring tab bolts, end-fitting tangs, snap rings, or rotating bearing cups can result in driveline failure, which can result in separation of the driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.

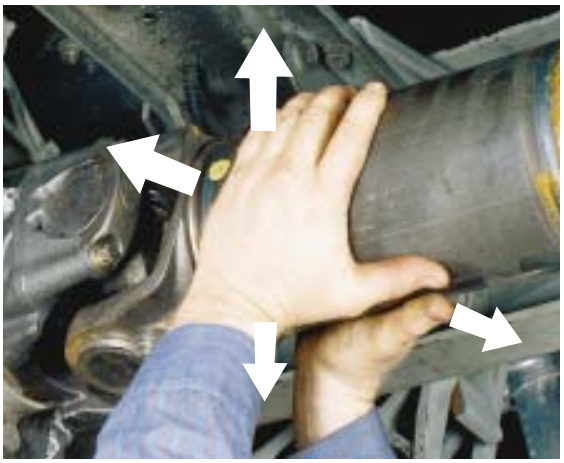


Photo 3

Photo 4, Relubable Style

UNIVERSAL JOINTS

5. Check for excessive looseness across the ends of the universal joint bearing cup assemblies and trunnions. Take hold of the inboard yoke on the driveshaft with both hands. Try to move yoke vertically and horizontally. (See photo 3, above.)

There should be less than .006 in. (.15mm) movement in the universal joint kit relative to the inboard or outboard yokes. If looseness is greater than .006 in. (.15mm), the universal joint kit must be replaced. ▲ See warning, below.

▲ ***WARNING***

Excessive looseness across ends of universal joint bearing cup assemblies can cause imbalance or vibration in the driveshaft assembly. Imbalance or vibration can cause component wear, which can result in separation of the driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.

6. Visually inspect all universal joint kits in the driveshaft assembly.

Relubable Style

7. Check for the presence of all grease zerk (nipple) fittings. (See photo 4, above). Grease zerk (nipple) fittings should not be missing, loose or fractured. ▲ See warning, below.

▲ ***WARNING***

A missing, loose or fractured grease zerk (nipple) fitting eliminates the ability to relubricate the universal joint. Neglecting to properly relubricate or inadequate lubrication can cause driveline failure, which can result in separation of the driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.

If grease zerk (nipple) fitting is loose, tighten to required specifications. (See Table B, below.)

If grease zerk (nipple) fitting is fractured, replace grease zerk (nipple) fitting and tighten to required specifications. (See Table B, below.)

UNIVERSAL JOINT GREASE ZERK (NIPPLE) FITTING SPECIFICATIONS

SERIES	GREASE ZERK P/N	MIN. ZERK TORQUE Nm	MIN. ZERK TORQUE FT. LB.
SPL90, SPL100, SPL140, SPL170 SPL250	232830	20.5	15.0

Table B

Photo 5, Permanently Lubricated Plug Style

Photo 6, Permanently Lubricated Net-Form Style

If grease zerk (nipple) fitting is missing, the entire universal joint kit needs to be replaced. Refer to the removal and installation sections of this manual for proper replacement procedures.

Permanently Lubricated Plug Style

8. Permanently lubricated plug style universal joint kits do not contain grease zerk (nipple) fittings, only a plug. (See photo 5, above.) Make sure plug is not missing, loose or fractured.

If the plug is loose, tighten to required specifications. (See Table B, step 7.) ▲ See warning, below.

▲ ***WARNING***

A missing, loose or fractured plug allows contaminants to invade the universal joint kit. Invasion of contaminants into the universal joint kit can degrade lubricant and can cause universal joint damage, which can result in separation of the driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.

If a plug is missing or fractured, the entire universal joint kit needs to be replaced. Refer to the removal and installation sections of this manual for proper replacement procedures. ▲ See warning, step 8.

Permanently Lubricated Net-Formed Style

9. Net-formed universal joints do not contain grease zerk (nipple) fittings or plugs and are not relubable. (See photo 6, above.)

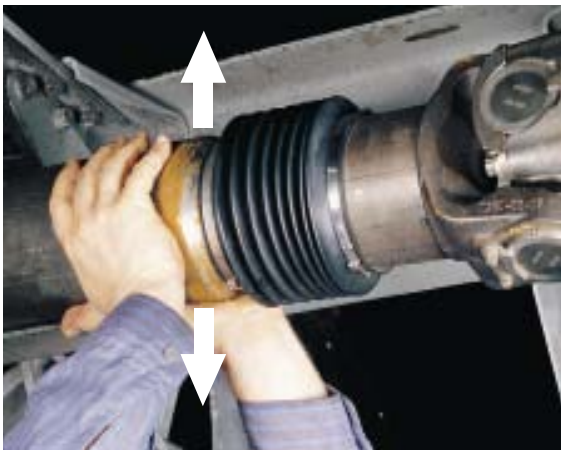


Photo 7

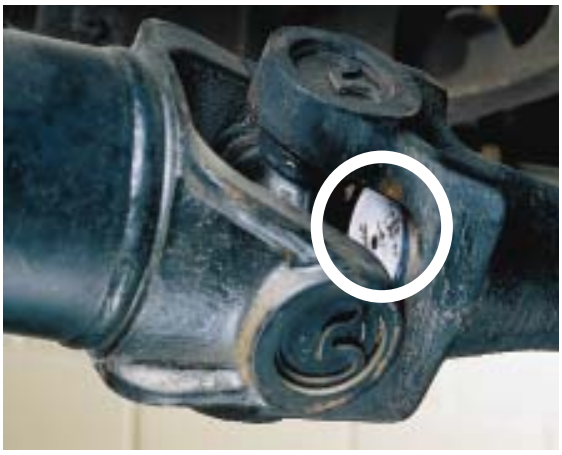


Photo 8

SLIP MEMBER ASSEMBLY

10. Check the slip member assembly for excessive radial looseness. Using a dial indicator, take hold of the tubing near the slip member with both hands and try to move vertically, up and down relative to the ground. There should be limited looseness in the slip member assembly. (See photo 7, above.) See warning, below.

If looseness is greater than .012 in. (.30mm) or greater as read on dial indicator, replacement of the slip member assembly is necessary. Refer to the removal and installation sections of this manual for proper replacement procedures.

WARNING

Excessive radial looseness can cause imbalance or vibration in the driveshaft assembly. Imbalance or vibration can cause component wear, which can result in separation of the driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.

Relubable Style

11. For an inboard and outboard slip yoke assembly design, check to be sure the slip yoke welch plug is not loose, missing or damaged. (See photo 8, above.) See warning, below.

If any of these situations are evident, replacement of the slip yoke and professional rebalancing of the driveshaft is necessary. Refer to the removal and installation sections of this manual for proper replacement procedures for slip members.

WARNING

A loose, missing or damaged welch plug allows contaminants to invade the slip member assembly. Invasion of contaminants into the slip member assembly can degrade the lubricant and cause slip member component damage, which can result in separation of the driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.

Photo 9

Photo 10

12. Visually inspect for the presence of the grease zerk (nipple) fitting, if applicable, on the slip yoke. (See photo 9, above.) Grease zerk (nipple) fittings should not be missing, loose or fractured. ▲ See warning, below.

▲ *WARNING*

A missing, loose or fractured grease zerk (nipple) fitting eliminates the ability to relubricate the slip member assembly. Neglecting to properly relubricate or inadequate lubrication can cause driveline failure, which can result in separation of the driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.

If grease zerk (nipple) fitting is loose, tighten to required specifications. (See Table C, below.)

SLIP MEMBER GREASE ZERK (NIPPLE) FITTING SPECIFICATIONS

SERIES	GREASE ZERK P/N	THREAD SIZE	ZERK TORQUE Nm	ZERK TORQUE IN. LB.
SPL90	500174-1	0.25"-28	3.5-6.2	31-55

Table C

If grease zerk (nipple) fitting is missing or fractured, the slip members may need to be replaced. Be sure to follow step 10 for inspection of radial looseness in slip member assembly.

If slip member assembly is within acceptable limits as stated in step 10, (page 14) install new grease zerk (nipple) fitting and tighten to required specifications. (See Table C, below). Be sure to completely relubricate slip member assembly with recommended lubricant. See lubrication section of this manual for proper procedures.

Refer to the removal and installation sections of this manual for proper replacement procedures for slip members.

13. Check the slip yoke seal. (See photo 10, above.) Make sure the seal is properly attached to the slip yoke and is not loose or damaged. ▲ See warning, below.

If any of these situations are evident, replacement of slip member assembly is necessary. Refer to the removal and installation sections of this manual for proper replacement procedures for slip members.

▲ *WARNING*

A loose or damaged slip yoke seal allows contaminants to invade the slip member assembly. Invasion of contaminants into the slip member assembly can degrade the lubricant and cause slip member component damage, which can result in separation of the driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.

Permanently Lubricated Style

14. Check yoke shaft boot (see photo 11, below) or seal can. Make sure the boot or seal can is properly attached to the yoke shaft and tube sleeve and no damage or looseness is apparent. Visually inspect boot for tears. Inspect boot or seal can for punctures. Inspect boot clamps for damage. ▲ See warning, below.

Photo 11

If any of these situations are evident, replacement of slip member assembly is necessary. Refer to the removal and installation sections of this manual for proper replacement procedures for permanently lubricated slip members.

▲ ***WARNING***

A loose or damaged slip member boot or seal can allows contaminants to invade the slip member assembly. Invasion of contaminants into the slip member assembly can degrade the lubricant and can cause slip member component damage, which can result in separation of the driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.

TUBING

15. Check the driveshaft for bent or dented tubing. If either of these situations is evident, replacement of the complete driveshaft assembly or tube is necessary. ▲ See warning, below.

▲ ***WARNING***

Bent or dented tubing can cause imbalance or vibration in the driveshaft assembly. Imbalance or vibration can cause component wear, which can result in separation of the driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.

16. Make certain there is no buildup of foreign material on the driveshaft. ▲ See warning, below.

▲ ***WARNING***

Buildup of foreign material on a driveshaft can cause imbalance or vibration in the driveshaft assembly. Imbalance or vibration can cause component wear, which can result in separation of the driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.

If found, buildup should be removed carefully to avoid damaging the driveshaft. (See Table D, below.)

REMOVAL OF FOREIGN MATERIAL

FOREIGN MATERIAL TYPE	REMOVAL METHOD
Asphalt, Tar or Undercoating	Mineral spirits or any appropriate solvent
Mud	Rinse off with water

Table D

Photo 12

CENTER BEARINGS

17. Visually inspect all center bearings, end-fitting midship nuts for any gaps between the mating surfaces. (See photo 12, above.) See warning, below.

Be sure to repeat steps 2 and 3, for all center bearing end fittings for broken back and backlash.

WARNING

A loose center bearing end-fitting midship nut can result in driveline failure, which can result in separation of the driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.

If gaps are present and steps 2 and 3 have been followed, see Table E, top right, for proper torque specifications and refer to the removal section of this manual for proper driveshaft removal procedures.

MIDSHIP NUT SPECIFICATIONS

SERIES	NUT P/N	WASHER P/N	HEAD SIZE	NUT TORQUE Nm	NUT TORQUE LB. FT.
SPL55	TBD	TBD	TBD	TBD	TBD
SPL70	TBD	TBD	TBD	TBD	TBD
SPL90	231502	N/A	1 5/8"	644-712	475-525
SPL100	TBD	TBD	TBD	TBD	TBD
SPL140	250-74-11	230123-6	41mm*	644-712	475-525
SPL170	250-74-11	230123-6	41mm*	644-712	475-525
SPL250	250-74-11	230123-6	41mm*	644-712	475-525

** A 1 5/8" socket may be used.*

Table E

18. Inspect the center bearing bracket bolts for looseness. (See photo 13, below.) See warning, below.

Photo 13

If looseness is evident, retighten center bearing bracket bolts. Consult the vehicle manufacturers' specifications for proper bolt torque. Check the alignment of the bracket before tightening the bolts. Bracket should not be skewed.

WARNING

Loose center bearing bracket bolt(s) can result in driveline failure, which can result in separation of the driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.

19. Visually inspect the center bearing rubber cushion for damage. Make sure the slingers are not rubbing against the rubber cushion. Verify that the rubber cushion is properly seated in the metal bracket. ▲ See warning, below.

If any of these situations are evident, replacement of the center bearing assembly is necessary. Refer to the removal and installation sections in this manual for proper center bearing replacement instructions.

▲ ***WARNING***

Damaged center bearings or center bearing components can cause imbalance or vibration in the driveshaft assembly. Imbalance or vibration can cause component wear, which can result in separation of the driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.

SPICER LIFE SERIES™ FEATURES & BENEFITS

Note – Spicer Life Series™ driveshafts are found on vehicles throughout the world. Therefore, this manual includes worldwide terminology. These terms have been highlighted in teal.

This manual encompasses inspection, lubrication, removal and installation procedures for Spicer Life Series™ 55, 70, 90, 100, 140, 170 and 250 driveshaft assemblies.

IMPORTANT FEATURES OF A SPICER LIFE SERIES™ DRIVESHAFT

Spicer offers a complete range of driveshaft solutions to meet the full spectrum of needs in medium and heavy duty applications. The Spicer Life Series™ driveshafts have been designed and developed to stand up to the wear and tear of heavy hauling tasks. They are the first driveshafts in the industry to be compatible with advancing powertrain specifications for higher engine torque and lower axle ratios. No one does more than Spicer in meeting the needs of the marketplace.

Spicer Life Series™ driveshafts offer:

- Longer life
- Lower lifetime maintenance
- Increased strength for higher engine torque and lower axle ratios
- Smaller driveshaft rotating diameter

A driveshaft that transmits high torque loads must be durable and strong. Spicer uses forged steel and high strength cast yokes to provide the necessary rigidity to maintain bearing alignment under torque loads. Spicer Life Series Quick Disconnect™ end yokes reduce the time to remove or install the driveshaft, equating up to a 75% labor savings for service. Applications requiring flange connections, S.A.E., DIN and cross-serrated T-Flanges are available. A new cold-formed, bearing retainer provides structural rigidity and reduces bearing movement which may result from overloading. New patented spring tabs, found on heavy duty Spicer Life Series™ assemblies and bearing retainers, increase bearing retention, reduce wear and optimize bearing capacity.

Spicer Life Series™ award winning* universal joint kits are specifically designed to give extended driveshaft life. Flat-ended needle bearings are used to withstand oscillating loads while the driveshaft is rotating and to eliminate skewing in the bearing cup. Thrust washers significantly reduce end galling on trunnion ends and lower universal joint operating temperature. Synthetic rubber seals and plastic seal guards provide lubricant retention and help prevent the entry of foreign material, significantly increasing universal joint life. The centrally located grease zerk (nipple) fitting increases the strength of the journal cross and allows more torque carrying capacity.

High-strength steel tubing is used to provide maximum torque carrying capacity at minimum practical weight. Increased tube diameter allows a higher critical speed and longer one-piece driveshafts. This increased stiffness also improves noise, vibration and harshness. New slip member booting or alternative seal can offers better protection against environmental contaminants, increases component life, and is lubricated for the life of the product.

The new integral tube sleeve and yoke shaft design, found on heavy duty Spicer Life Series™ designs, along with larger diameter involute splines, creates greater strength and torsional stiffness with less weight. This new design leads to improved balance and less slip effort, resulting in reduced noise and vibration for the entire driveshaft system. Spicer Glidecote,® found in all slip member assemblies, reduces friction, thereby lowering thrust loads under high torque. This nylon coating also prevents spline wear and extends life.

Spicer Driveshaft Division won the Automotive News PACE award for this bearing's innovative design, product and process technology.

GLOSSARY

Balancing – A procedure by which the mass distribution of a rotating body is checked and, if necessary, altered in order to ensure that the vibration at a frequency corresponding to an operating speed at the supporting bearings is within specified limits.

Ball Yoke – See Tube Yoke.

Bearing Cross Hole – See Cross Hole.

Bearing Cup Assembly – Consists of a bearing cup with needle rollers generally held in place by a seal guard and bearing seal. Sometimes the assembly includes a thrust washer.

Bearing Cup – A cup-shaped member used as the bearing bore of a bearing cup assembly and for positioning a thrust end of a cross trunnion.

Bearing Retainer – A heavy, formed metal cap, used solely in Spicer Life Series,® to retain a bearing cup assembly in Quick Disconnect™ end yoke or flange yoke designs.

Bearing Seal – A flexible member of a bearing cup assembly which prevents the escape of lubricant from or entry of foreign matter into a bearing.

Bearing Strap – A narrow, stamped metal plate used to retain a bearing cup assembly in a half-round end yoke or flange yoke design.

Boot – A flexible member which prevents the escape of lubricant from or entry of foreign matter into the slip spline members.

Boot Clamp – A thin adjustable band used to hold the boot in position on the slip spline members.

Boot Seal – See Boot.

Center Bearing – Consists of a rolling element bearing isolated in rubber and a bracket configuration for attachment to the vehicle frame.

Companion Flange – A fixed flange member that attaches a driveshaft to another drivetrain component.

Coupling Shaft – The coupling member or members of a multiple-piece driveline which consists of a universal joint, tube, center bearing, and a slip or fixed spline shaft.

Coupling Shaft Length (Center Line to Center Line or ℄ to ℄) – The distance between the outermost universal joint centers on a driveshaft. Coupling shafts with fixed centers, it is the nominal dimension.

Cross – See Journal Cross.

Cross Hole– A through hole in each lug ear of a yoke used to locate a bearing cup assembly.

Deflector – See Slinger.

Driveline – An assembly of one or more coupling shafts and a driveshaft with provisions for axial movement, which transmits torque and/or rotary motion at a fixed or varying angular relationship from one drivetrain component to another.

Driveshaft – An assembly of one or two universal joints connected to a tubular shaft member which accommodates axial movement.

Driveshaft Length (Center Line to Center Line or ℄ to ℄) – The distance between the outermost universal joint centers on a driveshaft. On driveshafts with variable length centers, it is usually measured in the compressed or installed lengths.

Ear – One of two projecting parts of a yoke symmetrically located with respect to the yoke's rotational axis.

End Fitting – An end yoke or companion flange (including S.A.E., DIN and T-Type styles) that attaches a driveshaft to another drivetrain component.

End Yoke – A Quick Disconnect™ yoke that attaches a driveshaft to another drivetrain component.

Flange Yoke – A full-round or Quick Disconnect™ style yoke which attaches a driveshaft to a companion flange.

Flinger – See Slinger.

Glidecote® – The blue, nylon, wear-resistant coating on Spicer yoke shafts and tube shafts.

Grease Zerk (Nipple) Fitting – The fitting on the shoulder or center of a journal cross or on a relubable slip spline that allows for lubrication.

Quick Disconnect™ Cross Hole – A semicircular hole located on the end of each lug ear of some end yoke and flange yoke designs used to locate a bearing cup assembly.

Inboard Yokes – Yokes that make up the ends of a driveshaft or coupling shaft assembly, i.e. tube yokes, slip yokes, yoke shafts, and center bearing end yokes.

Installation Height Tools – Round, indexing tools that are supplied with all Spicer Life Series® replacement universal joint kits to ensure proper bearing cup assembly installation specifications.

Journal Cross– The core component of a universal joint which is an intermediate drive member with four equally spaced trunnions in the same plane.

Lug Ear – See Ear.

Midship Shaft – A machined element consisting of spline teeth, a pilot for a center bearing and a piloting hub that attaches to the tube of a coupling shaft assembly.

Needle Rollers – One of the rolling elements of a bearing cup assembly.

Outboard Yokes – Yokes that are not a part of a driveshaft or coupling shaft assembly, i.e. transmission, axle, transfer case end yokes and/or companion flanges.

Phase Angle – The relative rotational position of each yoke on a driveshaft or driveline.

Pillow Block – Consists usually of a rolling element bearing and a bracket configuration for attachment.

Pressure Relief Hole – A hole in the welch plug of Spicer slip yokes that allows air to escape from the slip member assembly.

Purge – The act of flushing old grease and contaminants from universal joint kits and slip member assemblies with fresh grease.

Retaining Ring – See Snap Ring.

Retaining Ring Groove – See Snap Ring Groove.

Round Bearing Assembly – See Bearing Cup Assembly.

Seal Can – A metal "can" that permanently seals the slip member on a driveshaft. Usually found on European-style driveshaft assemblies.

Seal Guard – A covering member used to protect a bearing seal on the bearing cup assembly.

Serrated Flange – See T-Flange.

Shaft Support Bearing – See Center Bearing.

Slinger – A stamped metal or non-metal ring which prevents the entry of foreign matter into a center bearing, transmission, axle or transfer case.

Slip – The total permissible length of axial travel.

Slip Yoke – A yoke which accommodates axial movement.

Slip Yoke Plug – See Welch Plug.

Slip Yoke Seal – Pop-on or threaded ring that contains a seal that protects the slip member assembly from environmental contaminants and retains lubricant.

Snap Ring – A removable member used as a shoulder to retain and position a bearing cup assembly in a yoke cross hole.

Snap Ring Groove – A groove used to locate a snap ring.

Spline – A machined element consisting of integral keys (spline teeth) or keyways (spaces) equally spaced around a circle or portion thereof.

Spline Sleeve – A patented tubular-type, machined element consisting of internal splines which is attached to a tube or tube yoke in a driveshaft assembly. Found only in Spicer Life Series® driveshaft assemblies.

Spring Tab – A patented stamped metal plate that takes the place of a bearing plate and acts as a structural member by reducing looseness in a universal joint kit. Found only on Spicer Life Series® driveshaft assemblies.

Stub Shaft – See Tube Shaft.

Tang – A nib of metal found on Quick Disconnect™ end yoke and/or flange yoke style cross holes, used to locate a bearing cup assembly.

T-Flange – A companion flange and flange yoke design which has a serrated flange face. Found most often in European applications.

T-Type Flange – See T-Flange.

Thrust Washer – A washer found in the bottom of a bearing cup assembly that reduces needle roller friction, bearing heat and guards against end galling on the journal cross trunnions.

Tube – The tubular connecting member of a driveshaft. Pipe or piping is not an equivalent.

Tubing – See Tube.

Tube O. D. (outside diameter) – The outside diameter of a tube.

Tube Yoke – A inboard yoke with a piloting hub for attachment to a tube or spline sleeve.

Tube Shaft – A machined element consisting of spline teeth and a piloting hub that attaches to the tube of a driveshaft assembly.

Trunnion(s) – Any of the four projecting journals of a cross.

Universal Joint – A mechanical device which can transmit torque and/or rotary motion from one shaft to another at fixed or varying angles of intersection of the shaft axes. Consisting usually of a journal cross, grease zerk (nipple) fitting and four bearing cup assemblies.

Universal Joint Kit – See Universal Joint.

U-Joint – See Universal Joint.

Welch Plug – A plug in the slip yoke face that seals off one end of the spline opening. Also known as a slip yoke plug.

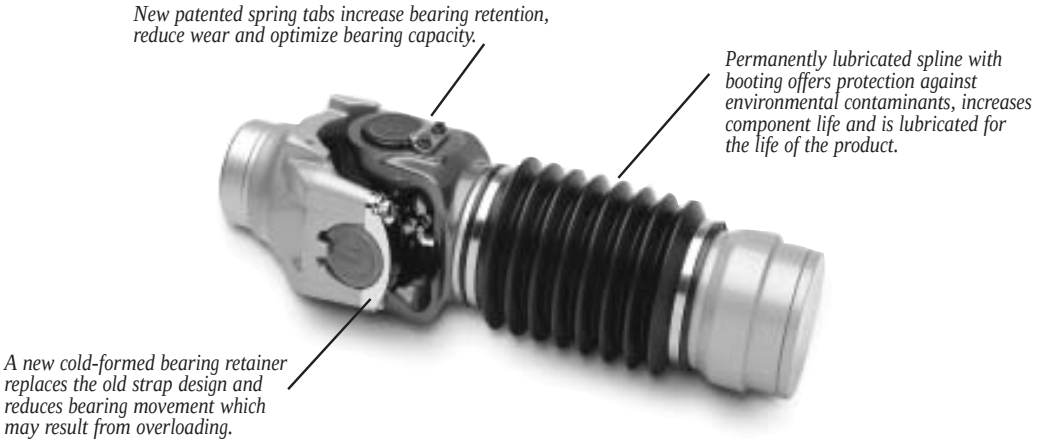
Weld Yoke – See Tube Yoke.

Yoke Lug Ear Cross Hole – See Cross Hole.

Yoke Shaft – A slip member yoke with a male machined spline used for axial movement.

Spicer Life Series™ Driveshaft – Quick Reference

SPICER® DANA



Maximum Lubrication* Cycles

Type of Service	Distance	Time
City	25,000 Mi./40,000 Km	or 6 months whichever comes first
On Highway	100,000 Mi./160,000 Km	or 6 months whichever comes first
On/Off Highway	25,000 Mi./40,000 Km	or 6 months whichever comes first
Highway/Industrial	500 hours for normal service and severe environmental conditions	250 hours for continuous service or whichever comes first

*Spicer recommends use of a high quality N.L.G.I., E.P. GRADE 2 lubricating grease

Bearing Retainer* Bolt Torque Specifications

Series	Socket Size	Bolt Torque	Assembly P/N
SPL140	12mm-12 point	135-160 Nm/100-120 Lb. Ft.	140-70-18X
SPL170	12mm-12 point	135-160 Nm/100-120 Lb. Ft.	170-70-18X
SPL250	12mm-12 point	135-160 Nm/100-120 Lb. Ft.	250-70-18X

*Spicer Life Series™ bearing retainers *MAY BE RE-USED* if not damaged. Spicer Life Series bearing retainer bolts *MAY NOT BE* re-used. Order bolt P/N 12-73-125M for all series.

Spring Tab Bolt* Torque Specifications

Series	Socket Size	Bolt Torque	Assembly P/N
SPL140	8mm - 6 point	35-40 Nm/20-25 Lb. Ft.	211941X
SPL170	8mm - 6 point	35-40 Nm/20-25 Lb. Ft.	211941X
SPL250	8mm - 6 point	35-40 Nm/20-25 Lb. Ft.	211941X

*Spicer Life Series™ spring tabs and bolts *MAY NOT BE* re-used. Order assembly part number.

Midship Nut Torque Specifications

Series	Nut P/N*	Nut Torque	Washer P/N
SPL140	250-74-11	644-712 Nm/475-525 Lb. Ft.	230123-6
SPL170	250-74-11	644-712 Nm/475-525 Lb. Ft.	230123-6
SPL250	250-74-11	644-712 Nm/475-525 Lb. Ft.	230123-6

*Wrench size 41mm

Boot Clamp Torque Specifications

Series	Clamp P/N	Clamp Torque	Assembly P/N
SPL140	232757	136-180 Nm/100-130 Lb. Ft.	212046X
SPL170	232493	136-180 Nm/100-130 Lb. Ft.	211959X
SPL170*	232702	136-180 Nm/100-130 Lb. Ft.	211987X
SPL250	232493	136-180 Nm/100-130 Lb. Ft.	211959X

*Used in high angle interaxle positions only.

SPICER®

DANA

Spicer Life Series™ Part Number Interchange

Description	Spicer Life Series Part Number	PACCAR	Navistar	Volvo	Freightliner	Mack
Spicer Life 170 U-Joint Kit	SPL170X		2500678C91	3947697	SP SPL170X	2104 SPL170X
Spicer Life 170 Bearing Retainer Kit	170-70-18X		2500674C91	3947699		2104 1707018X
Spicer Life Series Bearing Retainer Bolt	12-73-125M	12-73-125M	3513117C1	8082078	SP 12 73 125M	41AM7
Spicer Life Series Spring Tab Kit	211941X					
Spicer Life Series Boot Kit	211959X		2500671C91	3947801		
Spicer Life Series Boot Clip	232493			3947802		
Spicer Life Series Boot Kit	211987X		2500684C91	3947803		
Spicer Life Series Boot Clip	232702			3947804		
Spicer Life Series 170 Coupling Shaft End Yoke	170-4-11-1		2500658C1			2104 1704111
Eaton Tandem Axle	170-4-241-1X	170-4-241-X		8081933		176MU41P12 170MU51P36
Eaton Tandem Axle	170-4-161-1X					
Eaton Tandem Axle	170-4-201-1X	170-4-201-1X	3513133C91	8081927		176MU41P11 170MU51P25
Eaton Tandem Axle	170-4-221-1X	170-4-221-1X	3513134C91		SP 170-4-221-1X	
Eaton Tandem Axle	170-4-261-1X	170-4-261-1X				
Eaton Tandem Axle	170-4-281-1X	170-4-281-1X	3513135C91	8081932		176MU41P13 170MU51P37
Fuller Transmission	170-4-481-1X	170-4-481-1X	3513675C91	8081923		176MU41P20 176MU51P5
Fuller Transmission	170-4-521-1X	170-4-521-1X	3514642C91	8081924		176MU41P21 170MU51P6
Fuller Transmission	170-4-461-1X					170MU51P8
Rockwell Single Axle	170-4-671-1X	170-4-671-1X	3513842C91	8081937		176MU41P18 170MU51P31
Rockwell Single Axle	170-4-721-1X	170-4-721-1X	3514643C91	8081926		176MU41P22 170MU51P18
Spicer Single Axle	170-4-901-1X	170-4-901-1X	3517065C91			

Spicer Life Series™ Part Number Interchange

Description	Spicer Life Series Part Number	PACCAR	Navistar	Volvo	Freightliner	Mack
Spicer Life 250 U-Joint Kit	SPL250X		2500680C91	3947698	SP SPL250X	2104 SPL250X
Spicer Life 250 Bearing Retainer Kit	250-70-18X		2500675C91	3947800	SP 250 70 18X	2104 2507018X
Spicer Life Series Bearing Retainer Bolt	12-73-125M	12-73-125M	3513117C91	8082078	SP 12 73 125M	41AM7
Spicer Life Series Spring Tab Kit	211941X					
Spicer Life Series Boot Kit	211959X		2500671C91	3947801		
Spicer Life Series Boot Clip	232493			3947802		
Spicer Life Series 250 Coupling Shaft End Yoke	250-4-21-1			3947962		2104 2504211
Fuller Transmission	250-4-241-1X	250-4-241-1X	3513838C91	8081941		1NPN61008 181MU41P9 125MU53P6
Rockwell Tandem Axle	250-4-351-1X	250-4-351-1X	351839C91	3969891 8081943	SP 250 4 351 1X	181MU41P7 125MU53P16
Fuller Transmission	250-4-561-1	250-4-561-1	3519832C1			
Eaton Tandem Axle	250-4-61-1X					
Mack Transmission	250-4-621-1X					181MU41P4 125MU53P3
Eaton Tandem Axles	250-4-81-1X	250-4-81-1X	3517493C91	8081944		181MU41P5 125MU53P22

Spicer Life Series™ Part Numbering System for Driveshaft Assemblies

SPICER® DANA

Assemblies:	AAABBCDEEE-FFFF		
	AAA	=	Series
	BB	=	Description (see below)
	C	=	End Fitting on Slip End (Bearing End for Coupling Shaft)
	D	=	End Fitting on Tight End
	EEE	=	Spicer Sequential Number
	FFFF	=	Tube Length (In millimeters)
Example:	250DS25001-1234M*		
	Series	=	250 (SPL250)
	Description	=	DS (Driveshaft)
	End Fitting (Slip)	=	2 (Flange Yoke)
	End Fitting (Tight)	=	5 (Journal Cross)
	Sequence No.	=	001 of 999
	Tube Length	=	1234 Millimeters
	*M denotes millimeters		
Description:	Driveshaft	=	DS
	Coupling Shaft	=	CS
	Short Couple	=	SC
	Jack Shaft	=	JS
	Steering Shaft	=	ST
	Double Cardan Shaft	=	DC
	System Balance	=	SB
	Individual Joint	=	IJ
	Double Joint	=	DJ
	Dyno Shaft	=	DY
	Other	=	NA
End Fittings:	No Fittings/Other	=	0
	Companion Flange	=	1
	Flange Yoke	=	2
	Slip Yoke	=	3
	End Yoke	=	4
	Journal	=	5

Spicer Life Series™ Part Numbering System for Components

Components:	AAA-BB-CCCC-DE*		
	AAA	=	Series
	BB	=	Part Description (see below)
	CCCC	=	Spicer Sequential Number
	D	=	Denotes Half Round
	E	=	Denotes Assembly

*D and/or E may or may not be present in the component part number.

Description:	Companion Flange	=	1
	Flange Yoke	=	2
	Slip Yoke	=	3
	End Yoke	=	4
	Tube Yoke	=	28
	Yoke Shaft	=	82
Example:	250-4-241-1X*		
	Series	=	250 (SPL250)
	Description	=	4 (End Yoke)
	Sequence Number	=	241 (11-9999)
	Half Round	=	1
	Assembly	=	X

*The part number used in this example is a Spicer Life Series™ 250 half round end yoke assembly.

Webasto
Feel the drive

Coolant Heaters

Thermo 230.036
Thermo 300.066

Diesel - 24 Volts

Installation Instructions
Operating Instructions

02/2007
P/N 907507

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Thermo 230/300

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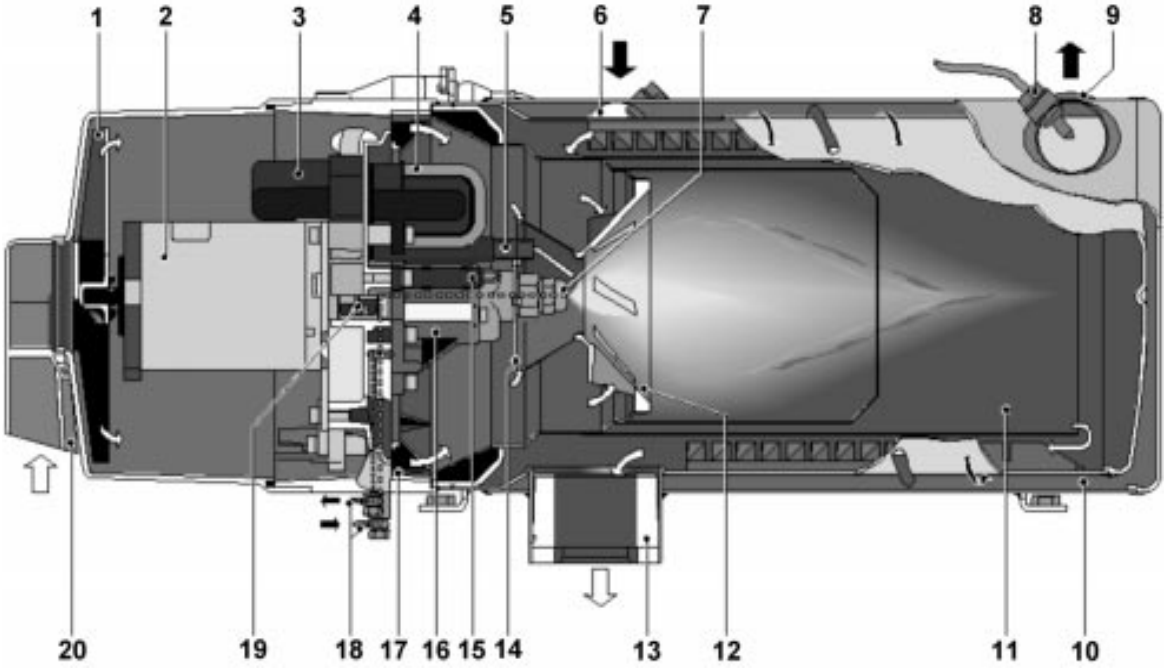
PART # 907 507
Rev. 11.15.98
Subject to modification

1. Introduction

1.1 General Description



1 Combustion air fan
2 Motor
3 Electronic control unit
4 Electronic ignition coil
5 Ignition electrodes
6 Water pipes
7 Fuel nozzle
8 Temperature sensor
9 Overheat thermostat
10 Heat exchanger
11 Combustion chamber
12 Combustion air swirler
13 Exhaust pipe
14 Photo disc
15 Flame detector
16 Fuel pump w/ solenoid valve
17 Combustion air adjusting shutter
18 Fuel supply / return
19 Coupler
20 Combustion air intake

Fig. 101: Webasto Thermo 230/300 Heater

The Webasto Thermo 230 and 300 Heaters for use on diesel powered transit buses and coaches are designed to:

1. **Preheat Engine block** of liquid cooled engines to ensure reliable starting in cold weather and to reduce cold start wear and emissions (white smoke).
2. **Boost heating levels** with the engine running. The heater will boost the heating system in cold weather when an engine is running at light loads, even at high speeds or idling.
   The heat rejection of modern diesel engines to the coolant, especially in buses, is often not adequate to heat the vehicle's interior.
3. **Increase Driver Visibility** in poor weather conditions by providing higher levels of heat for quick defrosting/defogging of windshield and side glass.

1.2 Legal provisions

Heater installation must be performed in accordance with the manufacturer`s installation instructions.
Any deviations from these instructions are only permitted with written approval from Webasto Thermosystems.
Installations not complying with the installation instructions will release Webasto Thermosystems from any product liability.
OEM installations must be approved by Webasto Thermosystems.

1.3 Meaning of Warning, Caution and Note

WARNING
This heading is used to highlight that non-compliance with instructions or procedures may cause accidents leading to severe injury or death.

CAUTION
This heading is used to highlight that non-compliance with instructions or procedures may cause damage to equipment.

NOTE
This heading is used to highlight and draw specific attention to information.

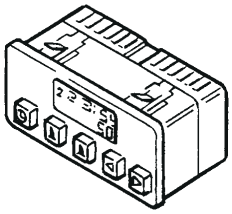
2. Operating your Webasto Heater

Before switching the Webasto water heater on, set vehicle heating system to the “heat” position and open any shut off valves. Depending on the type of control installed in the of the vehicle, the heater can be operated by the following methods.

WARNING
Due to the danger of poisoning and asphyxiation the heater must not be operated in enclosed spaces such as garages or workshops without adequate exhaust extraction.

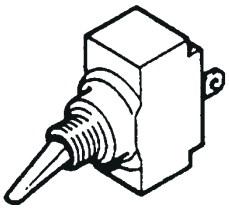
2.1 Switching On

Using a timer:



Timer

Using a switch:



Switch

WARNING
The heater must be switched “OFF” while refueling and at fueling stations.

WARNING
Do not operate any Webasto heater in an area where toxic or explosive materials or fumes may be present.

Upon actuation of the “instant heat” button the “operation indicator” on the timer lights up.

Or

When the switch is used for switching “ON” the Webasto heater, the operation indicator integrated in the switch is illuminated.

The heater motor and coolant circulating pump begin to run. After approximately 10-25 seconds the solenoid valve opens and fuel is sprayed into the combustion chamber. At the same time, the electronic ignition coil produces high voltage (8000 V) and the mixture of fuel and air in the combustion chamber is ignited by a spark produced at the tip of the ignition electrodes. The flame is detected by the photo cell, then the electronic ignition coil stops producing high voltage and combustion continues by itself (spark on electrodes is only required to ignite the flame). At this point the heater is working and produces heat.

The Webasto heater will cycle on and off until:

1. The Webasto heater is switched off.
2. Time has elapsed on the timer.
3. The vehicle battery voltage drops below 20.0V.
4. The Webasto heater runs out of fuel.
5. A fault lock out occurs, indicated by the operating indicator light being off during the cool down cycle (i.e. overheat).

2.2 Switching Off

When heating is no longer required, switch the Webasto heater off. The solenoid valve interrupts the fuel supply, combustion stops and the indicator light turns off. The Combustion air fan and the water pump remain on for another 2-3 minutes (after run cycle) purging the combustion chamber of any fumes.

NOTE
Restarting the Webasto during the after-run period is allowed.

2.3 Engine Pre-heating

1. Set the timer 30 min. to 1 hr. before you want to start engine. The heater will start up at set time. (See timer operating instructions beginning on page 203).
   Or switch the toggle switch or “instant on” switch on your timer in the vehicle dash to “ON”. The heater will start up.

2. When time is elapsed on your timer or engine preheat is no longer required, switch the Webasto heater “OFF”. The heater will go through the after-run cycle.

2.4 Boost Heating for Engine and Passenger Compartment

1. Switch the toggle switch (or the “instant on” button of the timer) in the vehicle dash to “ON”. The heater will heat the coolant to a temperature of 185°F (85°C). Above this temperature only the water pump will run.
2. When boost heating is no longer required, switch the Webasto heater “OFF”. The heater will begin a brief after-run (cool-down) cycle.

2.5 Operation with 7-Day Digital Timer Model 1531

The “Digital Timer with 3 time settings” permits the Webasto heater to be switched on and off instantly, or automatically at 3 programmable starting times.
The operating time of the heater can be pre-selected.
It is possible to program 3 different heating programs according to your individual needs.
Only one preset starting time can be activated at any one time.
When the vehicle’s ignition is switched on, the current time of the day and the day of the week are displayed.

Programmed Heater Operation
Three memory locations numbered 1 to 3 are available. Each memory location can be assigned a given time together with the day of the week.

Pre-selected Starting Times
The pre-selected starting time is the time at which the heater switches itself on automatically.
We recommend that memory locations 1 and 2 be used for presetting starting times within 24 hours of setting the timer.
Memory location 3 can be used for a starting time within the next 7 days of setting the timer.

Operating Time
The period of time during which the heater is in operation is referred to as operating time. The heater remains in operation for as long as the operating time has been preset.
Heater operation can be pre-selected for any time from as little as 1 minute to a maximum of 120 minutes (factory preset is 60 minutes).

NOTE
If the ignition is switched off while the heater is in operation, the remaining operating time of 5 minutes flashes on the display and the heater continues to operate for this period of time.

Remaining Operating Time
The remaining operating time refers to the period of time the heater still continues to remain in operation. It can only be changed while heater is in operation.

Setting the Digital Timer
After the power has been connected, all symbols on the digital display are flashing. The time of the day and the day of the week must be set.
All flashing displays and symbols of the timer can be set by means of the ◀ and ▶ buttons.
If the buttons are not pressed within 5 seconds, the currently displayed time or function will be stored.
When the ◀ and ▶ buttons are pressed for more than 2 seconds, the quick digit advance mode is activated.

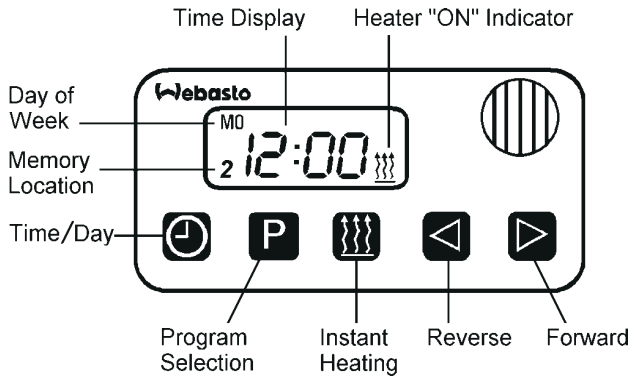


Fig. 201: 7-Day Digital Timer – Model 1531

2.6 7-Day Digital Timer Programming and Operating Instructions

Setting the time and day of the week	Press the button for more than 2 seconds. Time display flashes. Press the ◁ or ▷ button to set time of day. Wait 5 seconds. Time is now stored. Day of week flashes. Press ◁ or ▷ button to set day of week. Wait 5 seconds. Day of week is now stored.
Viewing the time	With ignition “ON”: Continuous display of current time and day of the week. With ignition “OFF”: Briefly press button. Display of current time and weekday appears for 5 seconds.
Switching heater on for instant heater operation	With ignition “ON”: Press button. Heater is switched on (continuous heating) and continues to operate until button is pressed again or ignition is switched off. With ignition “OFF”: Press button. Heater is switched on for the preset operating time (the factory-set heater operating duration is 60 minutes).
Switching the heater off	Press button. Heater starts its after-run cycle and is switched off thereafter.
Programming heater starting time	Press P button. Memory location number flashes. Press ◁ or ▷ button to preset starting time. Wait 5 seconds. Preset starting time is now stored. Day of week flashes. Press ◁ or ▷ button to set day of week. Wait 5 seconds. Day of week is now stored. The number of memory location remains on the display. The timer is now in the programmed mode and switches heater on at the preset time.
Recalling pre-selected times	Press P button until the desired memory location number is displayed. Read off preset time.
Canceling pre-selected times	Press P button repeatedly until no more memory location number is visible on the display.
Programming duration of operating time	The heater must be switched off. Press the ◁ button. Operating time flashes. Press ◁ or ▷ button to set operating duration time (between 1 and 120 minutes).
Setting the remaining operating time	Heater must be in operation. Press ◁ button. Remaining operating time flashes. Press ◁ or ▷ button to set remaining operating time. Wait 5 seconds. Remaining operating time is now stored.

Table 201: Digital Timer Instructions

NOTE
If the ignition is switched off while the heater is in operation, the remaining operating time of 5 minutes flashes on the display and the heater continues to operate for this period of time.

NOTE
We recommend that memory locations 1 and 2 be used for presetting starting times within 24 hours of setting the timer. Memory location 3 can be used for a starting time within the next 7 days of setting the timer. By repeatedly pressing P button, starting time 1, 2 or 3 can be preset.

3. Technical Data

3.1 Thermo 230/300 Heater Data

Heater		Thermo 230	Thermo 300
Design		Coolant Heater with High Pressure Fuel Nozzle	
Heat Output	BTU/hr (kW)	80,000 (23)	104,000 (30)
Fuel		Diesel #1, Diesel #2, Arctic and Kerosene	
Fuel Consumption max.	Kg/hr (US. gal/hr)	2.5 (0.8)	3.3 (1.2)
Rated Voltage	(V)	24	
Operating Voltage	(V)	20 ... 28	
Power Consumption without Water Pump	(W)	65	110
Permissible Ambient Temperature during Operation	°C (°F)	-40 ... +60 (-40 ... +140)	
Storage Temperature	°C (°F)	+85 max. (+185 max.)	
Minimum Capacity of Cooling System	l (US. gal)	10.0 (2.64)	
Permissible Operating Pressure of Coolant	bar (psi)	0.4 ... 2.0 (06 ... 29)	
CO_2 in Exhaust Gas	% by Volume	10.5 ±0.5	
Dimensions of Heater mm (inch)	L W H	610 mm (24.01 in.) 246 mm (9.69 in.) 220 mm (8.66 in.)	
Weight of Heater including Control Unit	kg (lb)	19 (41.88)	

Table 301: Thermo 230/300 Heater Data

3.1.1 Thermo 230/300 Heater Dimensions

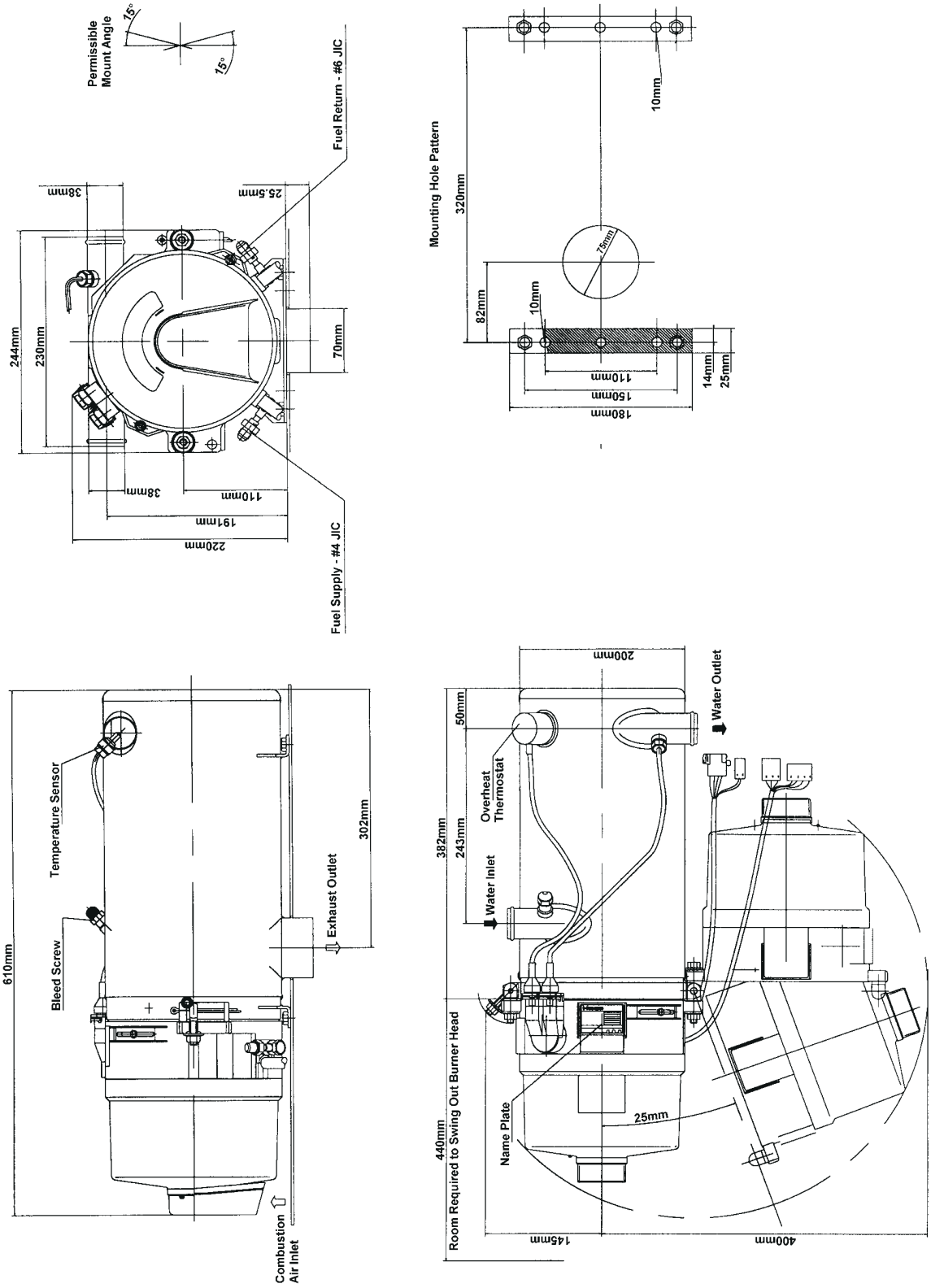


Fig. 301: Thermo 230/300 Heater Dimensions

3.2 Coolant Circulation Pump Data

Circulating Pump		U 4814	U 4851
Flow Rate l/hr	l/h (gal/min)	5200 (22.9) against 0.2 mbar	6000 (26.4) against 0.4 mbar
Rated Voltage	(V)	24	24
Operating Voltage Range	(V)	20 ... 28	18 ... 32
Power Consumption	(W)	104	209
Dimensions mm (inch)	L W H	221 mm (8.7 in.) 100 mm (3.94 in.) 105 mm (4.14 in.)	285 mm (11.22 in.) 115 mm (4.52 in.) 110 mm (4.33 in.)
Hose connection	mm (inch) O.D.	38.0 (1.5)	38.0 (1.5)
Weight	kg (lb)	2.1 (4.63)	2.7 (5.95)

Table 302: Coolant Circulation Pump Data

3.2.1 Coolant Circulation Pump Dimensions

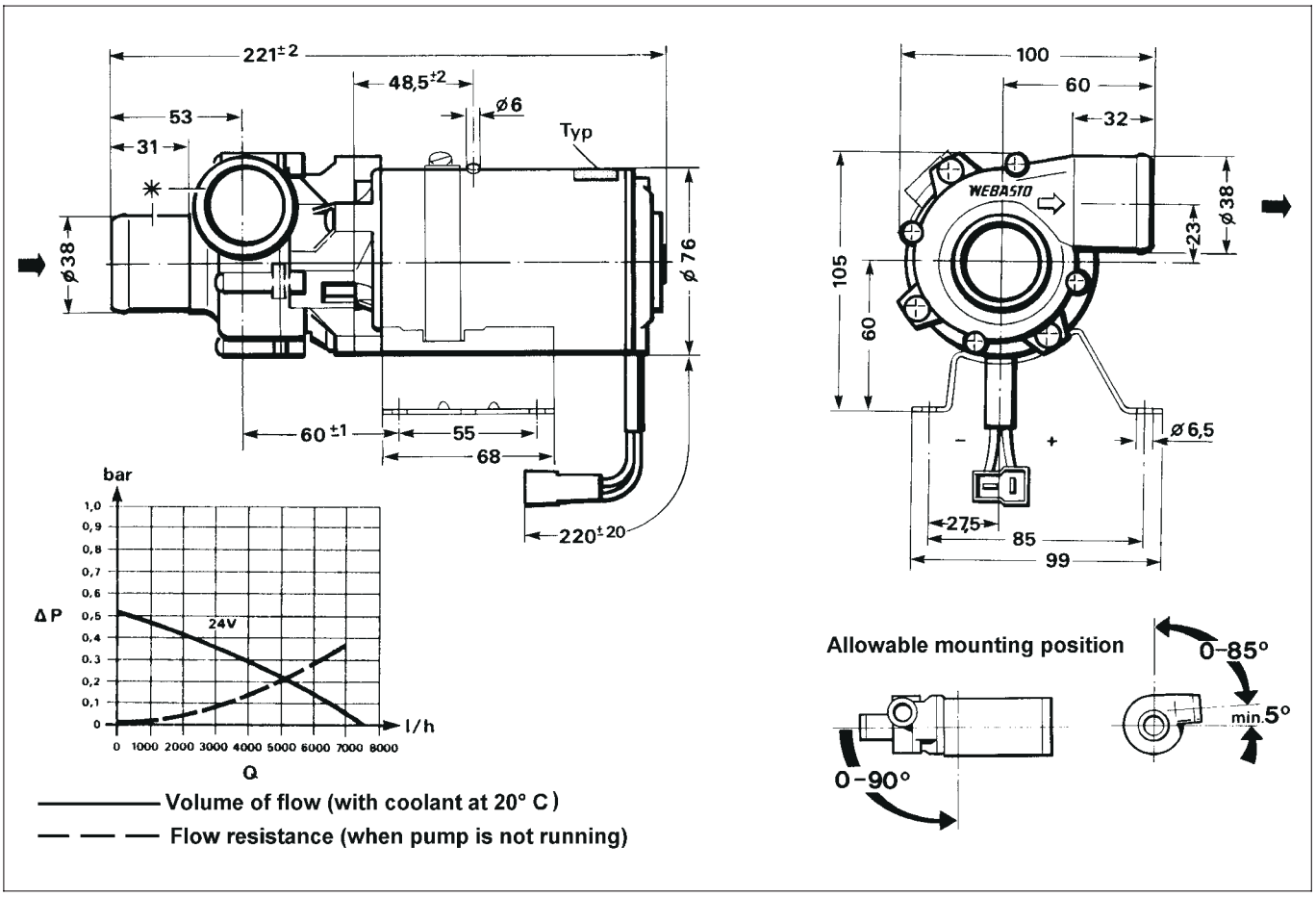


Fig. 302: Coolant Circulating Pump Assembly - U 4814

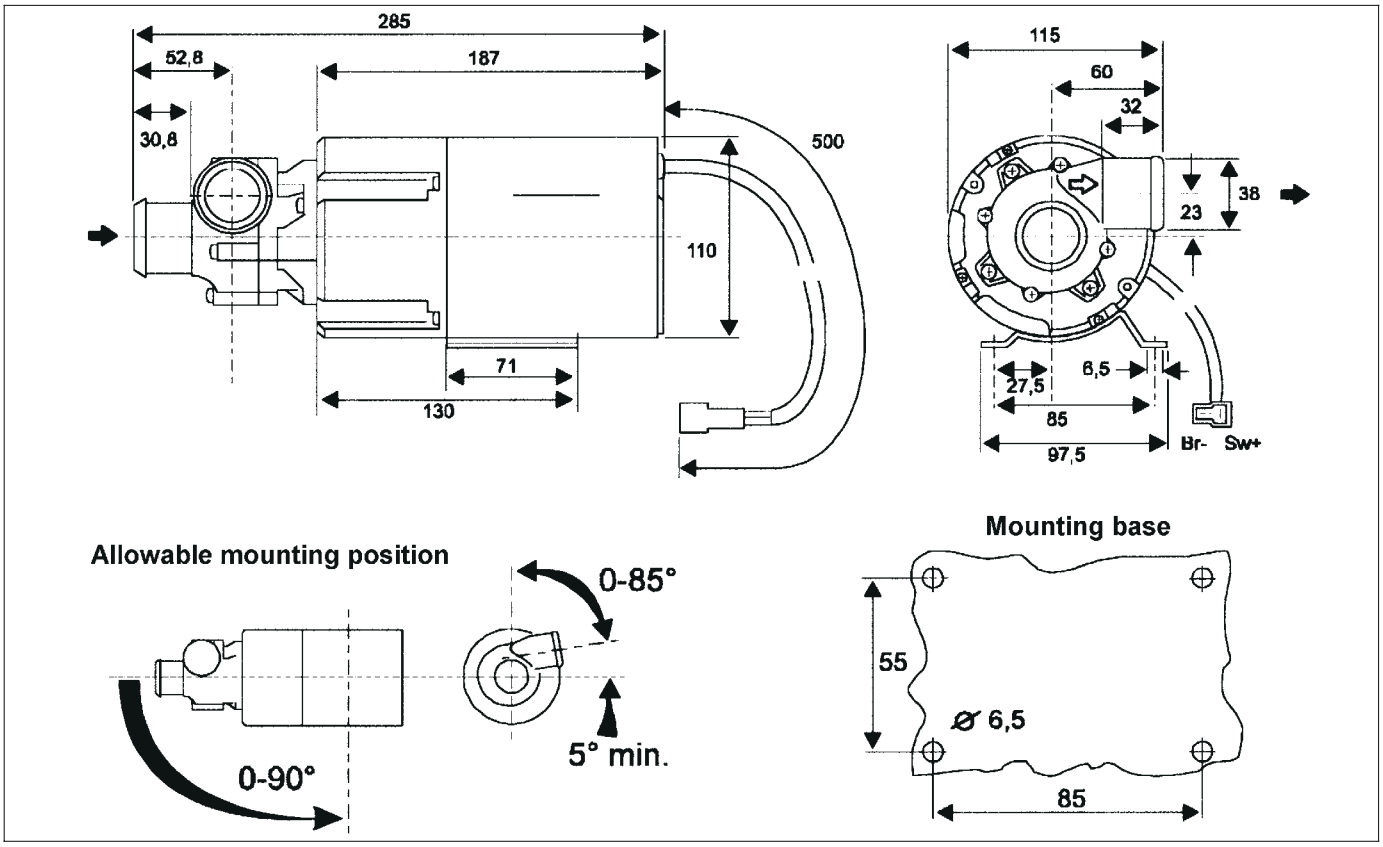


Fig. 303 Coolant Circulating Pump Assembly - U 4851

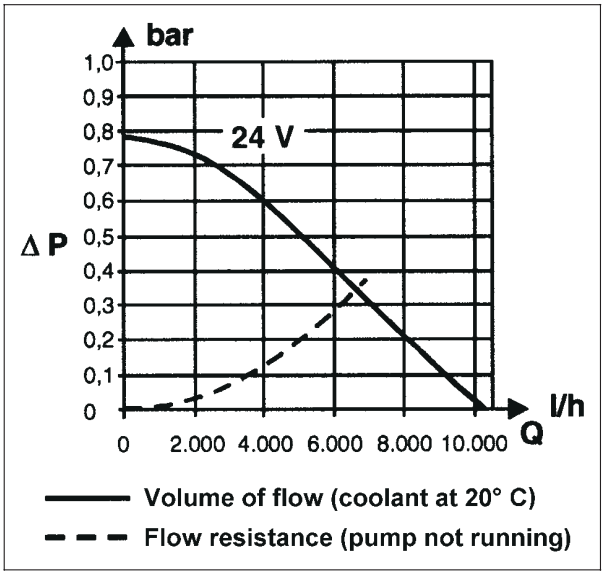


Fig. 304 Pump Operating Data - U 4851

4. Installation

> **NOTE**
> This manual does not cover all possible installations. For special applications use this manual as a general guideline only. Contact Webasto Thermosystems directly at 1-800-555-4518.

4.1 General Information

Webasto will take you step by step through the installation process to ensure successful operation for years to come. The installation must be performed in accordance with the installation instructions provided in this manual.

IMPORTANT! The proposed heater installation must be approved by Webasto Thermosystems.

4.2 Installation Location

> **WARNING**
> The heater must not be installed in either the driver's compartment or in the passenger area of vehicles.

The heater and circulation pump are to be integrated into the coolant system (or into a separate heating circuit, if applicable) of the vehicle. The heater should be installed as low as possible in the coolant system to assure static bleeding of the heater and the circulating pump.

> **NOTE**
> The circulating pump is not self priming.

The heater is to be installed in a clean and dry environment, usually a separate compartment, accessible for service, typically towards the rear of the vehicle. The heater may also be located in the engine compartment. The installation enclosure must provide adequate ventilation for combustion air requirements [4 in² (20 cm²)].
When installing the heater, make certain that the clearances required for accessing the unit for servicing are observed (e.g. removal of the combustion chamber). See figure 301, page 302.

4.3 Mounting the Heater

1. Drill all required holes to dimensions shown in figure 301, page 302.
2. Bolt heater rigidly inside enclosure or engine compartment.

4.4 Exhaust Pipe Connection

> **WARNING**
> Exhaust pipes must be so routed that the possibility of exhaust fumes entering the vehicle is unlikely.

Rigid exhaust pipe is recommended in installations where the use of an exhaust deflector is not suitable. The exhaust pipe must have a minimum internal diameter no less than 2 3/4" (70mm) and a length no greater than 16' (5m). The pipe may have several bends totaling no more than 270° overall. Do not cut and weld pipe to make 90° angled corners.

1. Install exhaust deflector on heater exhaust outlet or install exhaust pipe.
2. Route the exhaust system so that the possibility of discharged exhaust gasses entering the vehicle is prevented.
3. Direct the discharge opening of the exhaust system in such a way as not to be pointed in the direction of travel, and so located that the possibility of clogging caused by snow, mud or debris is prevented.
4. Any condensation water collecting in the exhaust pipe must be discharged. If necessary, drill a drain hole at the lowest point to allow drainage.

NOTE
Route the exhaust system away from any parts of the vehicle that may be damaged by heat (i.e., brake lines, electrical wiring, hoses and fuel lines).

NOTE
Additional flexible exhaust tubing Webasto part number 479 721.

4.5 Combustion Air Supply

Never draw combustion air from inside the passenger area of a vehicle, or from areas where fumes and gasses can accumulate.

WARNING
Never draw combustion air from inside the vehicle, or from areas where fumes or gases can accumulate

Where heater is installed in a sealed compartment, adequate ventilation for combustion air requirements [4 in² (20 cm²)] must be provided.

Combustion air can be drawn from a remote (protected) area in order to provide a clean air supply.
For installations requiring remotely drawn combustion air, use approved ducting with an unrestricted internal diameter no less than 2 1/4" (55mm) and a length no greater than 16’ (5m). The ducting may have several bends totaling no more than 270° overall.
Approved combustion air ducting can be ordered through Webasto under part number 887 29A.

CAUTION
Combustion air ducting must be non-restrictive. Do not connect to existing vehicle air ducting or filtration systems.

NOTE
Approved combustion air ducting can be ordered under Webasto part number 887 29A.

To connect combustion air intake ducting [2 1/4" (55mm)] to the heater, several types of fittings are available that snap directly onto the combustion air inlet of the heater.

For a straight connection, order a straight adapter under part number 101 377 and snap it onto the combustion air inlet and attach air ducting.

In the event there is insufficient room for a straight attachment, a 90° snap-on fitting (P.N. 101 404) and an adapter ring (P.N. 823 15A) are available. Simply snap them onto the combustion air inlet of the heater and attach ducting.

For installations where ducting is not required, the heater is factory equipped with a splash deflector that simply snaps onto the combustion air inlet.

4.6 Plumbing Into the Coolant System

WARNING
When working on the coolant system, allow the engine to cool down and open the radiator cap carefully.

4.6.1 General Information

An efficient heating system must have an adequate supply of hot water to all heater cores. The amount of hot water available to a typical three or more heater core system depends on the water pumps capability and the amount of restriction within the coolant system.

Webasto high performance circulating pumps designed for extensive heating applications are available. Installing a Webasto heater and circulating pump in accordance with the following instructions will maximize the heating systems efficiency.

CAUTION
The Webasto heater relies on coolant flow to transfer heat from the heater to the vehicle's heating system. The coolant pump(s) must be operating and there must be a path for coolant to flow or the heater will overheat.

Coolant typically is routed out of the engine, through the Webasto coolant heater and then through the vehicle's heating system.
A path for coolant flow must always be maintained while the Webasto heater is in operation. A bypass loop will be required if an uninterrupted coolant flow path cannot be assured due to valves being closed while the Webasto heater is in operation. The coolant circulating pump(s) must operate while the Webasto heater is "ON."

The coolant circulating pump must be mounted as low as possible in the vehicle's cooling system. A minimum of 10% of a good quality antifreeze should be maintained in the cooling system at all times. Heater and water pump fit 1.5" (38 mm) I.D. heater hose meeting SAE 20 R3 specifications. Silicone hose requires special hose clamps.

NOTE
Heater hose must meet SAE 20 R3 specifications. Silicone hose requires special hose clamps. Hose clamps must be tightened to 45 in/lb. (5 Nm) torque.

4.6.2 Engine and Passenger Compartment Heating

A: Heater Cores arranged in Series (fig. 401)
A series heating system works in this fashion:
Heated water (coolant) from the engine travels through the first heater core in the circuit, then on to the next heater core in circuit, and on to the next, etc. Each core adds some restriction, resulting in decreased water flow. Not only is water flow reduced, but also water temperature is reduced by each successive heater core resulting in the last core receiving water that is usually too cool to be effective.

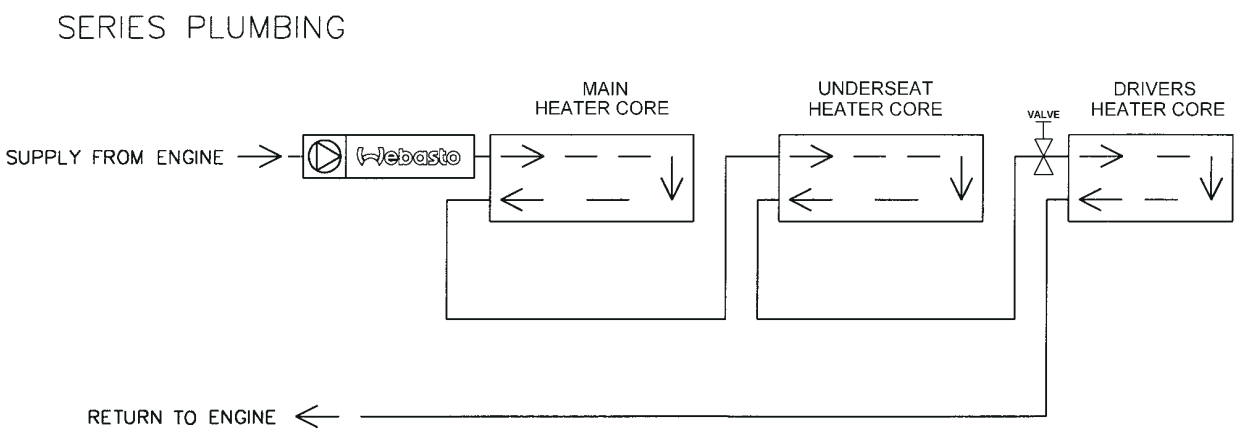


Fig. 401: Series Plumbing Circuit (Shown with heater installed)

CAUTION
A path for coolant to flow must be provided whenever the Webasto heater is operating.

B: Heater Cores arranged in Parallel (fig. 402)
A parallel heating system works in this fashion:
Heated water (coolant) from the engine travels through a common supply and return circuit, but unlike a series system, the heater cores are connected across the circuit at intervals along its length.
Each core shares the available coolant and heat equally, resulting in increased heating efficiency and decreased coolant restriction.

CAUTION
Water pump(s) must be operating when the Webasto heater is in operation..

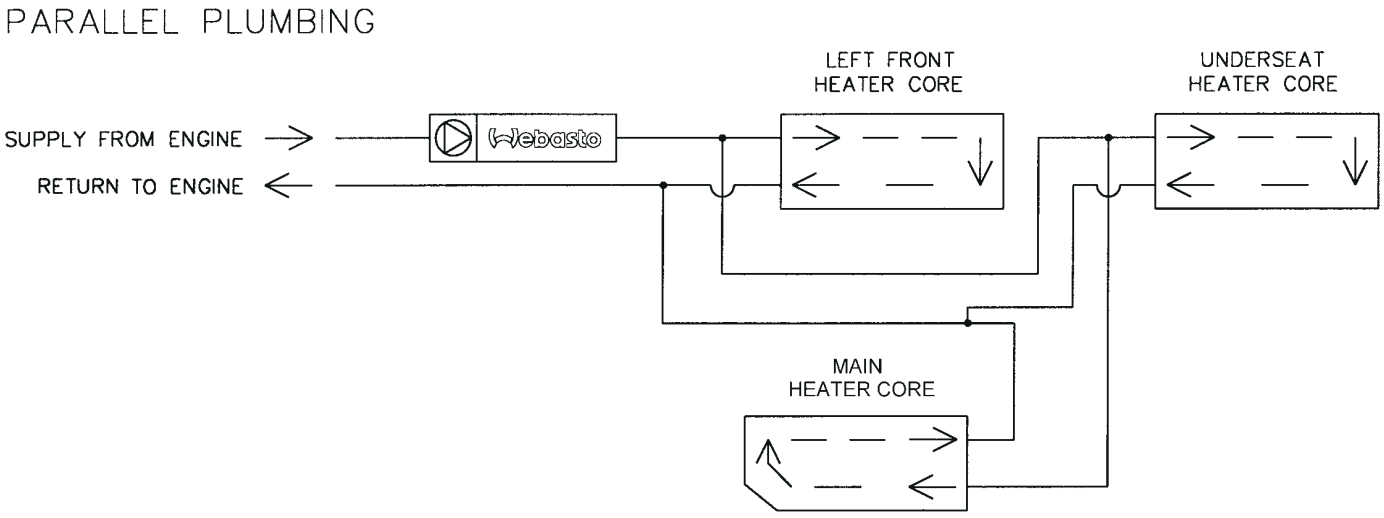


Fig. 402: Parallel Plumbing Circuit (Shown with heater installed)

A fuel fired Webasto heater used in conjunction with a high capacity coolant pump can significantly increase the available heat and coolant volume supplied to both series and parallel systems increasing interior heating efficiency. With the addition of a timer, the above systems can also provide pre-heating capability.

C: Engine pre-heating and/or Boost Heating Only (fig. 403)
This type of installation is used where engine pre-heating and or system boost heating is the primary requirement. The heater can be installed across the heating circuit before any of the vehicle heating cores or installed independently of the vehicles heating circuit by plumbing directly from and returning back into the engine. Depending on how the Webasto heater is controlled (timer, switch, vehicle system), heat can be supplied for engine pre-heating and maintaining higher operating temperatures. Interior heating efficiency will be enhanced by the higher operating temperatures provided by boost heating.

WARNING
When working on the coolant system, allow the engine to cool down and open the radiator cap carefully.

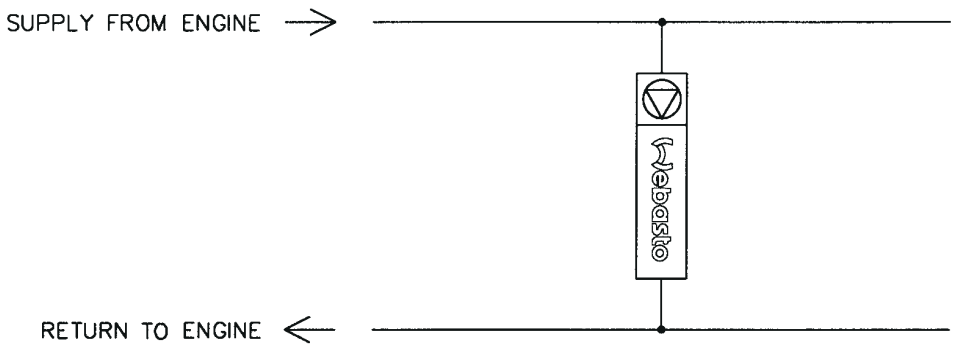


Fig. 403: Engine Preheat/Boost Heating Circuit

Instructions for options A, B or C (Typical installations)

On typical systems, the coolant supply will originate at the engine. From there, it will travel through the supply hose to the Webasto coolant pump (or vehicle manufacturer supplied boost pump), through the pump and into the fuel fired heater where the coolant is heated during operation. The heated coolant then leaves the heater at the outlet and continues on through the vehicles heating system and returns to the engine.

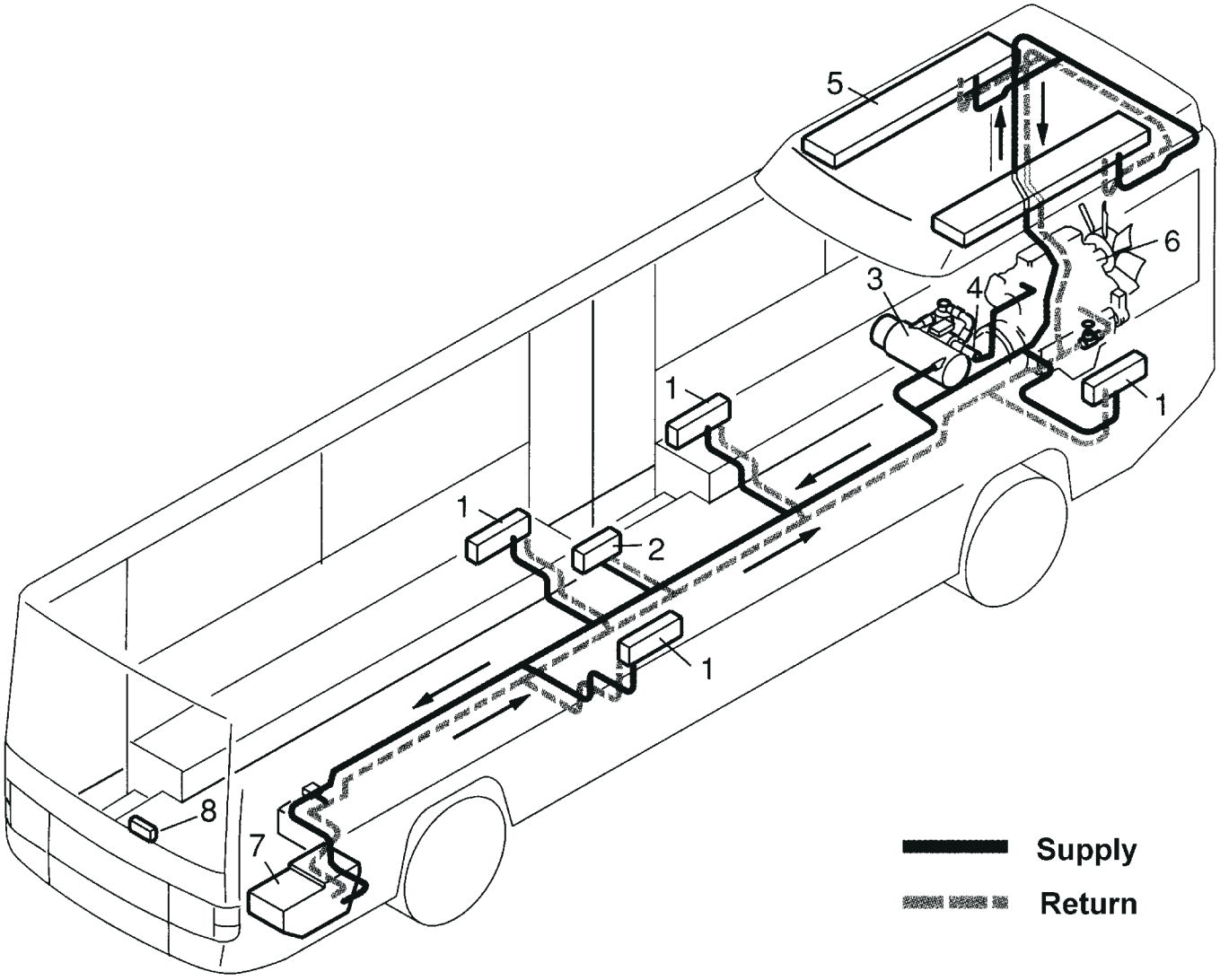
NOTE
Silicone hose requires special hose clamps.

NOTE
Heater hose must meet SAE 20 R3 specifications.

1. Identify the type of system you are working with to determine the appropriate type of installation as shown in figures 401, 402 or 403.
   - find and identify heating circuit supply hose. This is the starting point for determining the type of plumbing configuration you will choose.
2. Connect heater into the system according to the examples shown in figures 401, 402 or 403.

NOTE
Hose clamps must be tightened to to 45 in/lb. (5 Nm) torque.

4.6.3 Example of a Heater Installation in a Bus



1 Heat Exchanger with Fan
2 Stepwell Heater
3 Webasto Coolant Heater
4 Circulation Pump
5 Heat Exchanger, Roof
6 Vehicle Engine
7 Drivers Heater
8 Heater Control

Fig. 404: Example of Heater Installation

4.7 Fuel System

NOTE
The heater is equipped with an internal self priming fuel pump.

4.7.1 General Description

The fuel is drawn from the vehicles fuel tank through a fuel standpipe. This standpipe can be utilized on vehicles with a spare threaded port as shown in figure 405. The Webasto heater utilizes 37° flare JIC fuel connection fittings. The fuel supply line fitting is a JIC #4 and the return line is a JIC #6.

4.7.2 Fuel Supply

IMPORTANT!
Keep the submerged end of fuel standpipe at least 2" from bottom of fuel tank.

CAUTION
If the fuel tank is higher than the Webasto heater, the top of the tank may not be more than 20" above the heater.

The fuel standpipe and fuel line must be installed according to these instructions to insure proper heater operation.

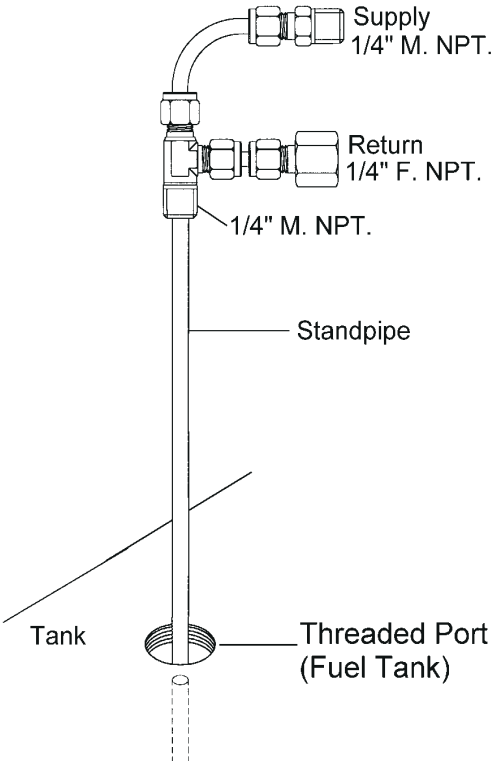


Fig. 405: Fuel Standpipe Installation

1. Cut fuel standpipe to length, approx. 2" off fuel tank bottom.
2. Install the fuel standpipe.

NOTE
After fuel standpipe has been cut to length, remove any burrs.

- use 1/4" or 1/2" spare port on fuel tank (if available) and install fuel standpipe securely in fuel tank, use pipe thread sealant on all pipe threads.

3. Route and secure fuel lines from heater to fuel tank. Route according to applicable regulations.
   Use grommets to protect fuel lines whenever routed through holes.
4. Connect fuel lines to fuel standpipe and heater using 1/4" (6 mm) I.D. fuel line. Steel braided fuel lines are recommended for installations where the heater is located in the engine compartment.

CAUTION
Fuel line must be secured every 12" and kept away from hot exhaust and moving parts (drive shaft, wheels, etc.).

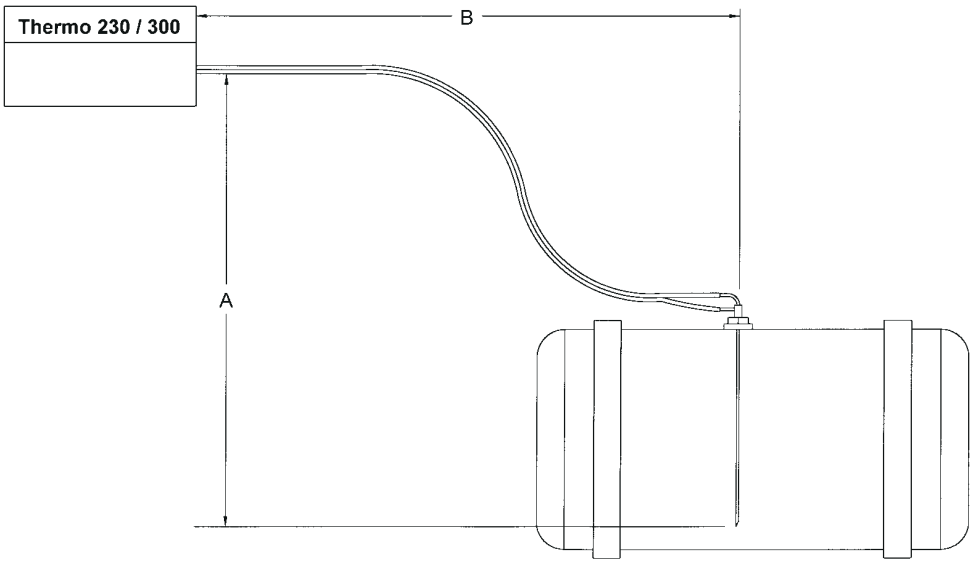


Fig. 406: Fuel Line Parameters

A = Suction height 6’6" (2,0 m)
A+B = Suction length and height not to exceed 33’ (10 m)

4.7.3 Fuel Filter

The heater must be equipped with a fuel filter. Fuel filters require changing at least annually and in cases of dirty fuel more often.

NOTE
Change the fuel filter at least annually.

The fuel filter assembly should be mounted near the heater.

After installation, before the heater is fired for the first time, the fuel system and filter will require priming. In most cases, this will be achieved by turning on the heater and allowing it to self prime.
In some cases the fuel filter may require filling with CLEAN diesel fuel before installation to assist system priming.

CAUTION
To prevent fuel nozzle failure, always use CLEAN fuel from a known CLEAN source for priming fuel systems and filters.

4.8 Wiring Connections

NOTE
The Webasto heating system will not perform to your satisfaction with weak batteries.

CAUTION
If welding is done on the vehicle, the main battery cables must be disconnected from the battery to protect the electronic control unit.

4.8.1 General Information

The control unit is equipped with low voltage protection, therefore it is imperative to keep vehicle batteries in good condition.
Thermo 230/300 heaters are available in 24 volt configurations only.

4.8.2 Timer and Switch Connections

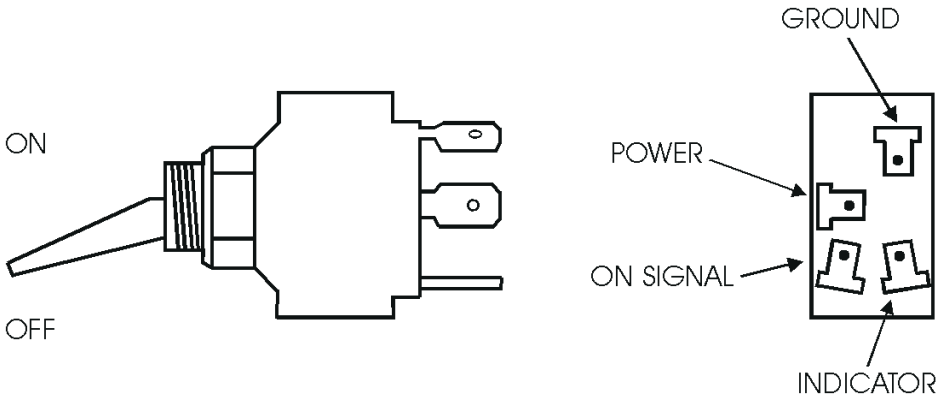


Fig. 407: On/Off Switch

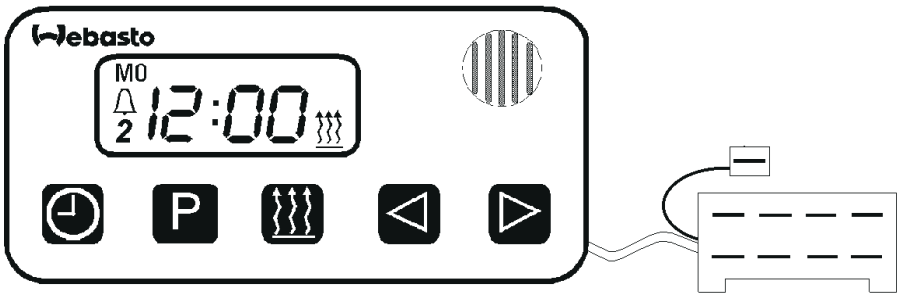


Fig. 408: 7-Day Digital Timer Model 1531

4.8.3 Timer or Switch Installation

1. Select a suitable location in the vehicle for the timer or On/Off switch.
2. Connect the harness to the timer, or switch.

4.8.4 Wiring Diagram - with Switch

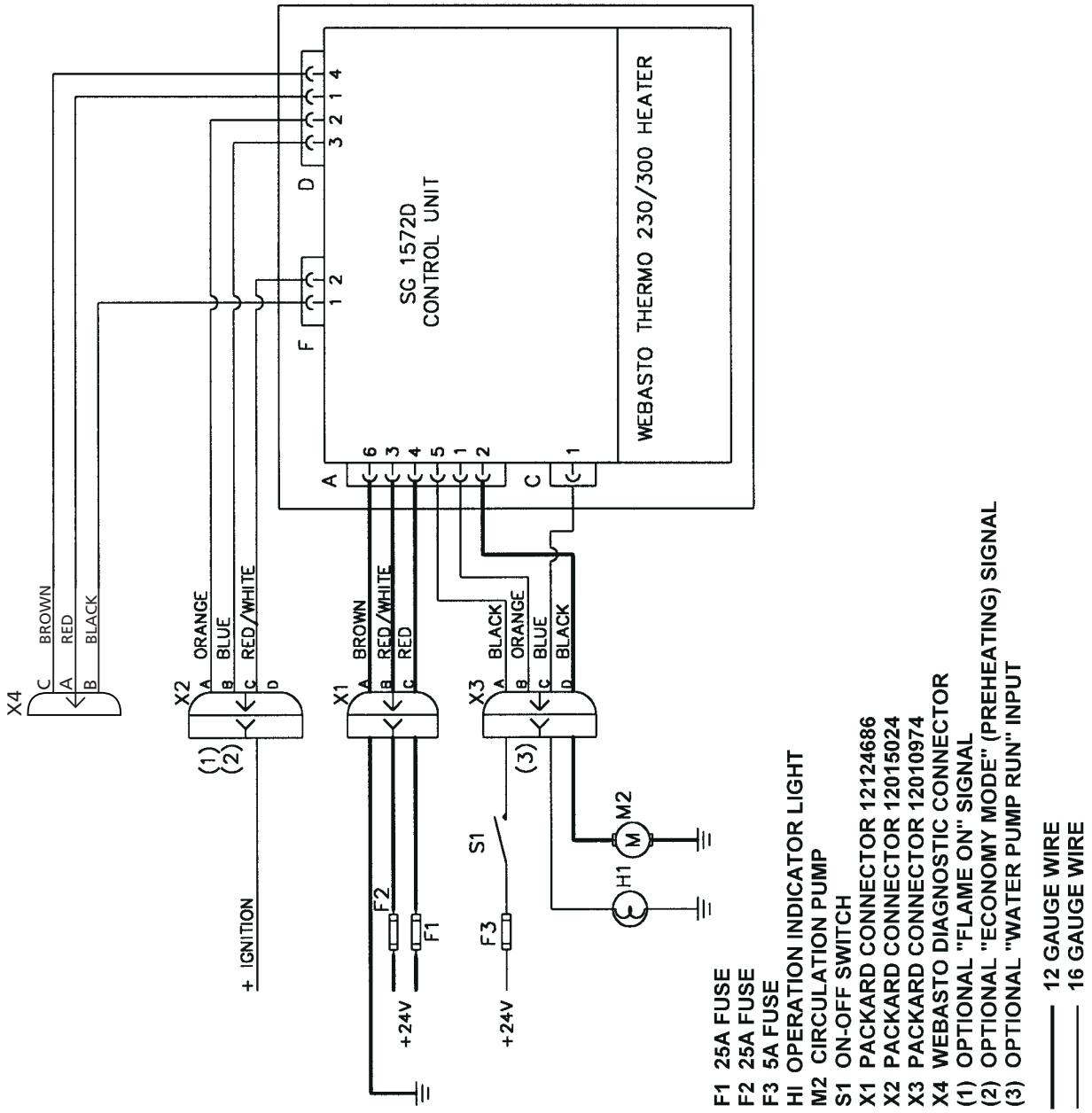


Fig. 409: Wiring Diagram with Switch

4.8.5 Wiring Diagram - with 7-Day Digital Timer Model 1531

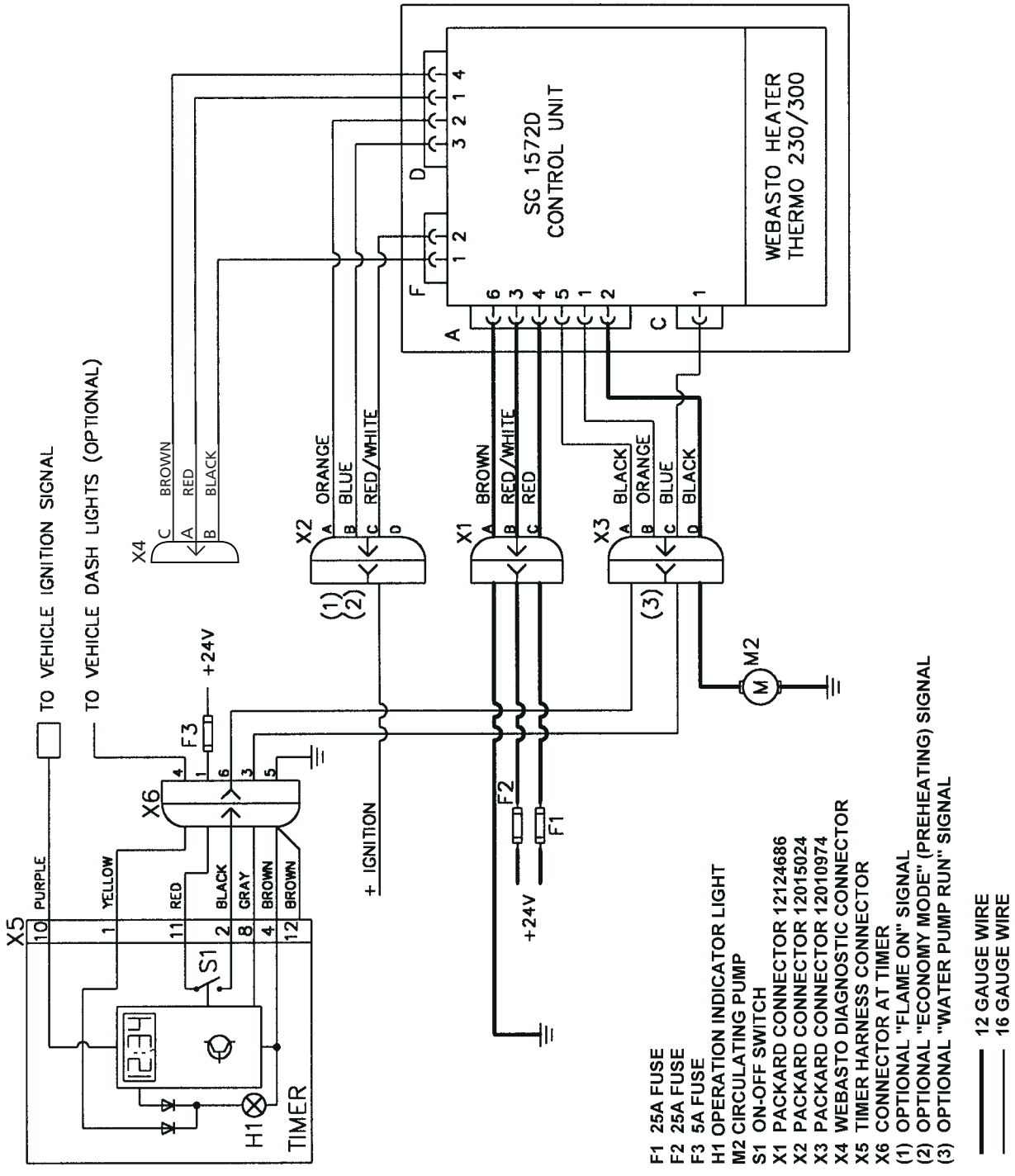


Fig. 410: Wiring Diagram with Timer Model 1531

4.9 Initial Operation

1. Check your installation for:
   - loose nuts and bolts.
   - exhaust pipe routing and clamp tightness.
   - loose hose clamps.
   - routing and securing of wiring and heater hoses.
   - kinked or pinched hoses.
   - battery connection and polarity.

2. Top off or refill cooling system with coolant as per engine manufacturers recommendations.

3. Open shut-off valves and driver's heater valve.

4. Set vehicle heater controls to maximum heat position.

5. Start the vehicle engine and run it at a fast idle for 10 minutes to purge air from the Webasto coolant heater and all of the heat exchangers. While the engine is running check:
   - hose connections for leaks.
   - coolant level in the expansion tank and add coolant as needed.
   - use bleeder valve on top of Webasto heat exchanger to purge out trapped air when necessary.

6. Switch on Webasto heater and check:
   - indicator light on.
   - circulating pump in operation.
   - heater fan motor in operation.
   - presence of combustion after approximately 25 seconds.

NOTE
Installation with long fuel lines may need a second start attempt to initially prime the fuel system. Cycle ON/OFF switch or timer to reset control unit.

7. Shut off the engine.

8. Allow heater to run until coolant is hot and heater cycles off. During this period, monitor system for any coolant or fuel leaks.

NOTE
Coolant temperature must be below 158°F (70°C) to start up.

9. Temperature differential between water inlet and outlet should not exceed 10° C (18° F) during heating operation.

10. Switch "OFF" Webasto heater.

11. Re-tighten hose clamps to 45 in/lb. (5 Nm) and inspect installation for leaks.

14. Install any panels and access covers removed during installation.

15. Complete the warranty card and send to Webasto Thermosystems (There is an area on the last page of this manual for recording information which is useful when calling for technical support).

16. Install the compartment cover if equipped. Installation is now complete.

NOTE
The engine temperature gauge may read a lower temperature depending on the location of the temperature sensor on the engine.

NOTE
Necessary information to complete warranty card and ensure full warranty coverage can be found on name plate.

5. Maintenance of the Heater

5.1 Annual Maintenance

The Webasto heater requires a minimum of maintenance to operate. To keep your heater in service the following maintenance procedures should be performed annually before each heating season:

NOTE
For major repairs and spare parts, return to your authorized Webasto Thermosystems servicing Specialist.

Enclosure Area

- clean the heater and enclosure area from any accumulated debris or dust with compressed air
- inspect all components for wear and damage

Electrical System

- check wiring harnesses for damage, fix or replace if required
- check condition of the batteries and connections.
- load test batteries and replace if necessary.

NOTE
The heater will not function properly with weak batteries.

Exhaust System

- check the exhaust system carefully for restrictions or corroded areas. Replace exhaust pipe if necessary.

Fuel System

- change fuel filter and inspect fuel lines for wear and damage. Repair or replace if necessary.

Burner System

- swing open burner head, clean flame detector (photo eye), pull out combustion chamber and inspect and clean heat exchanger. Replace nozzle if necessary (annually). Re-install combustion chamber and close up burner head.

Operation Test

- Run your heating system for at least 15 minutes.
- Check water and fuel connections for leakage. Re-tighten clamps and fittings if necessary.

NOTE
Operate your Webasto at least once a month for 10 minutes.

6. Basic Troubleshooting

CAUTION
Troubleshooting requires profound knowledge about structure and theory of operation of the heater components and should only be performed by skilled personnel.

6.1 General Information

This section describes troubleshooting procedures for the Thermo 230/300 coolant heater.
Troubleshooting is normally limited to the isolation of defective components.

Before troubleshooting, check for and eliminate these defects:
- **fuel supply (plugged fuel filter)**
- **corrosion on battery terminals**
- **blown fuses**
- **corrosion on electrical wiring, connections and fuses**
- **loose contacts, or improper crimping on connectors**
- **shut down initiated by temperature limiter thermostat (automatic reset)**

NOTE
After any correction of a defect a functional test has to be performed in the vehicle.

NOTE
Coolant temperature must be below 158°F (70°C) to start up.

6.2 Operational Failure Symptoms (reading the flash code)

A flash code will be generated on the indicator light of the control (on / off) switch in the event of an operational failure. In order to make a correct analysis it's necessary to understand the flash code event. The flash code event is only visible during the after run (cool down) period of operation.

During the flash code event you will see the following:

Five quick flashes followed by a slower sequence of flashes, the slower sequence of flashes is the actual fault code. The first five quick flashes are only an indication that a fault code has been registered and will be displayed. Count only the slower sequence of flashes to obtain the current fault code.

For example (flashes = ¤):
Fault code 7X (F 07): ¤¤¤¤¤ ... ¤ ... ¤ ... ¤ ... ¤ ... ¤ ... ¤ ... ¤

The flash code sequence will be repeated during the Thermo 230/300 after run (cool down) period and will remain visible once heater stops in the lock out mode. Once the heater is cycled "OFF" and "ON" the fault code will no longer be visible on the indicator light but will be stored in memory.

6.2.1 Reading a Fault Code with 1531 “Comfort” Timer Installed

CAUTION
Troubleshooting requires profound knowledge about structure and theory of operation of the heater components and may only be performed by skilled personnel.

Where the Thermo 230/300 installation includes the model 1531 “Comfort” Digital Timer, you will be able to read the current failure fault code directly from the timer display. The flame indicator symbol will “flash” the present fault code once and will then convert the fault code to an alphanumeric display message.
For example: fault code 10 (overheat) will be visible on the timer display as “F 10".
Once the failure has been corrected, and the heater switch or timer is cycled ”OFF" and “ON” and the heater successfully starts and runs with no further failures, the error code will disappear from the timer display.

NOTE
After any correction of a defect a functional test has to be performed in the vehicle.

6.2.2 Storing a Fault Code in Memory

Once the Thermo 230/300 completes the after run (cool down) period initiated by a failure event, the current flash code will be downloaded (stored) in memory.
The Thermo 230/300 can store up to ten fault codes.
Once the memory is “full”, any additional fault code will replace the earliest code stored thereby continually updating the fault codes stored in memory with the four most recent faults.

6.3 Operational Failure Symptoms via Fault/Flash Code

The following table lists the possible faults which can be read by flashing code or read directly off of an appropriate timer or with the PC diagnostics kit.

Failure Symptom	Probable Cause	Check and Correct
1X Flash (F 01) No combustion after completion of start up sequence.	- Fuel system - Combustion air - Electronic ignition	- Fuel level - Type of fuel being used - Fuel filter - Fuel line connections (air bubbles in fuel lines) - fuel nozzle plugged - Air intake or exhaust, restricted or plugged - incorrect electrode gap
2X Flashes (F 02) Flame out during burner operation no restart possible	- Fuel supply (shortage of fuel)	- Restriction in the fuel system - Fuel filter - Fuel line connections (air bubbles in fuel lines) - Type of fuel being used
3X Flashes (F 03) Low voltage for more than 20 seconds	- Electrical system	- Load test batteries - Corrosion at connections - Loose connections
4X Flashes (F 04) Flame detector recognizes false flame signal during pre-start or shut-down cycle	- Defective flame detector	- Replace flame detector
5X Flashes (F 05) Flame detector	- Wiring - Defective flame detector	- Damaged wiring, open or short circuit - Replace flame detector
6X Flashes (F 06) Temperature sensor	- Wiring - Defective temperature sensor	- Damaged wiring, open or short circuit - Replace temperature detector
7X Flashes (F 07) Fuel solenoid valve	- Wiring - Defective solenoid valve	- Damaged or corroded wiring, open or short circuit - Replace solenoid valve
8X Flashes (F 08) Combustion air fan motor	- Wiring - Wrong RPM - Defective combustion air fan motor	- Damaged wiring, open or short circuit - Replace combustion air fan - Replace combustion air fan
9X Flashes (F 09) Circulation pump motor	- Wiring - Defective circulation pump motor	- Damaged wiring, open or short circuit - Replace circulation pump motor
10X Flashes (F 10) Temperature limiter	- Overheat condition - Coolant flow - Wiring - Defective temperature limiter	- Reset temperature limiter - Coolant level or flow restriction - Air trapped in coolant circuit - Damaged or corroded wiring, open or short circuit - Replace temperature limiter
11X Flashes (F 11) Electronic ignition coil	- Wiring - Defective electronic ignition coil	-Damaged wiring, open or short circuit -Replace electronic ignition coil
12X Flashes (F 12) Heater lock out	3 repeated faults/flame-outs or 5 repeated start attempts	Reinitialize control unit by switching heater on and disconnecting power.

Table 601: Operational Failure Symptoms (Control Unit SG 1572 D)

6.4 Reading and Removing Fault Codes Stored in Memory with the Webasto PC Diagnostics Kit and Adapter

CAUTION
Diagnostics equipment is intended for use by Webasto trained personnel at authorized Webasto Distributor, Dealer and End User service facilities.

It is possible to read and remove (reset) stored fault codes from the Thermo 230/300 memory.
This is achieved through the use of a diagnostic interface kit connected to the Thermo 230/300 and an IBM compatible computer having the necessary software installed.

The PC Diagnostic Interface Kit comes with software and instructions for use with Webasto heaters equipped with internal diagnostics capabilities such as the Thermo 230/300.

Order PC Diagnostics Kit under part number 925 42A and adapter under part number 208 65A.

System requirements:
- IBM compatible PC with 80286 processor or higher
- DOS version 3.0 or higher including *MS Windows (*Not required)
- at least 1 MB RAM
- hard disk with at least 3 MB space available
- 3 1/2 inch, 1.44 MB floppy disk drive for installation of program files
- VGA graphics board with 640 x 480 pixel resolution and at least 16 colors
- unused serial port
- monitor, keyboard (mouse or other pointing device recommended)

In addition to working with stored fault codes, the PC Diagnostics Kit allows you to do several other functions such as reading values while the heater is in operation or testing individual components. Printing out of fault codes is also available (User supplied printer required).

For further capabilities and detailed instructions for use with the Thermo 230/300 heater, see instruction manual supplied with the PC Diagnostics Kit.

7. WARRANTY POLICY *

Webasto Thermosystems Inc. and Webasto Thermosystems (Canada) Ltd., (herein after referred to as “Webasto”) warrants their products and related component parts against defects in materials and workmanship for 24 months effective from installation date or vehicle registration date for O.E.M. installations. The warranty period may not however, exceed 36 months from the original date of delivery by Webasto.

During the warranty period the EXCLUSIVE REMEDY will be for Webasto to repair or replace those parts which are demonstrated to be defective in material or workmanship.

In the event of a defect covered by this warranty, only Webasto authorized distributors/dealers are permitted to perform warranty work. Call Webasto @ 1-800-Heater-1 (1-800-432-8371) or, in Canada @ 1-800-667-8900 for your closest Webasto authorized dealer.

Please complete and return the Webasto warranty registration card immediately upon installation or registration of new vehicle.

Webasto specifically excludes and limits from warranty the following:

- **Normal wear of service parts including:** *Fuel nozzles, filters and fuses.*
- **Improper installation,** *which is not in accordance with valid supplied installation instructions.*
- **Deterioration,** *due to normal wear and tear, corrosion, abuse, damage, accident, improper storage or operation.*
- **Modification,** *of a product by alteration, use of non genuine parts or repair by unauthorized personnel.*
- **Economic loss,** *for expenses related to travel, vehicle disassembly, personal injury or other incidental or consequential damages.*

* See official warranty for complete details

Webasto

Feel the drive

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Fenton, MI 48430

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Canada: (800) 667-8900

www.webasto.us
www.techwebasto.com

Org. 10/1998 Rev. 02/2007 P/N 907507

DINEX G2A MULTIPLEX SYSTEM

FOR

COACHWORKS BUS

Rev. 1.0
08-30-02

I/O CONTROLS CORPORATION

I/O CONTROLS CORPORATION

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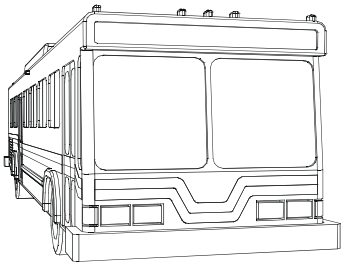


http://www.iocontrols.com

Contents

1

Key Nomenclature

Data Bus	The multiple pair of common wires providing the multiple DATA path and/or power supply to link each network element. Similar to a telephone line.
Module	The network functional unit which contains the intelligent co-processor unit. The vital communications data link to IO devices, inputs and outputs.
Bus Controller	The communication traffic controller that directs and regulates communication between each functional unit on the data bus. Think of the Bus Controller as a telephone switchboard.
Node	An individual functional module in the network. The telephone receiver in a network.
ID	The unique address symbol (either a number or a character) which is assigned to each functional unit in the network. A telephone number.
I/O	Inputs (sensors and switches) and Outputs (actuators or lamp loads). These are the fundamental system functions.
DNET	The unique name for DINEX G2A system to be defined as UPLINK data port. Acting as Slave Function.
CNET	The unique name for DINEX G2A system to be defined as DOWNLINK data port. Acting as Controller Function.

Clean Power (Computer Power) The isolated power source for modules in the network. “Clean Power” avoids data corruption from a common power source such as battery or electrical interference.

LED A light emitting diode. A small semi-conductor lamp.

Reset Restart the system.

Cellnet Controller This CNC module has the capability to act as a subset of Master Bus Controller (G2A-MBC-32) which includes 32-inputs and power management function.

HCNC A high speed cell network controller.

DIO An intelligent slave module.

Multiplex A way of transmitting several lines of communication simultaneously on the same data link.

Inputs Switches and sensors, which supply information to the modules to perform an operation. A circuit is “active” when it is turned on. A circuit is “inactive” when it is turned off. The computer can make use of both “active” and “inactive” data to perform a specific function.

Data The information from module to module over Multiplex system.

Outputs All physical actions that are performed by the modules, such as turning on or off lights, solenoids and other devices.

Ring Loop Data bus structure in which the modules are connected to form a “ring.”

Ladder Charts Ladder charts, circuits, or diagrams are logic diagrams. They are not schematics. The primary function of a ladder diagram is to show how devices are related one to the other.

2

General Description

What is MULTIPLEX (MPX)?

- MPX simplifies the way electrical devices are hooked up together.
- MPX allows for two or more data transmissions to take place on the same wire.
- In the world of traditional wiring systems -- such as wiring harnesses, and relays -- as much as three miles of wires can be used. These harnesses run hundreds of signals, using hundreds of wires, just to keep a single transit vehicle operational.
- Instead of having three miles of complicated wiring harnesses and a number of failure prone connectors, multiplexing sends multiple signals at the same time through a common pair of wires to turn-on or turn-off various electrical devices.

Some of the problems encountered with the old technology are:

- Cumbersome systems,
- Relay based,
- Over-crowded -- making upgrading and maintenance difficult,
- Prone to connector and harness failure,
- Costly to troubleshoot and repair,
- Expensive vehicle downtime.

Multiplex hardware which makes-up the system is composed of:

- A separate power supply,
- Several control modules.
- And a unique cabling system made up of connectors and multi-stranded wires that run through a cable.

Some of the benefits of MPX are:

- A simple system,
- Reduced number of connectors,
- Immediate ease of troubleshooting,
- Reduced vehicle down-time,
- Ease of operation.

What will DINEX G2A Intelligent MPX do for me?

DINEX-G2A-MPX advances transit vehicle control techniques into the computer age.

- The DINEX-G2A-MPX system provides a reliable, cost-effective alternative to the old technologies.
- The DINEX-G2A-MPX system replaces relays, flashers, connectors, and outdated wiring harnesses.
- The DINEX-G2A-MPX system offers an intelligent network for the control, monitoring and data acquisition in transit bus and rail cars.
- The DINEX-G2A-MPX system's bottom line is to make your life easier and less costly.

How does DINEX-G2A-MPX system do all this?

- The DINEX-G2A-MPX is a microprocessor-based system. It uses multiplex data-bus architecture.
- The DINEX-G2A-MPX uses a small, compact, powerful module to perform full computer functions. This central module controls a family of small, lightweight microprocessor-based control and monitor functions.

DINEX G2A Working in Bus

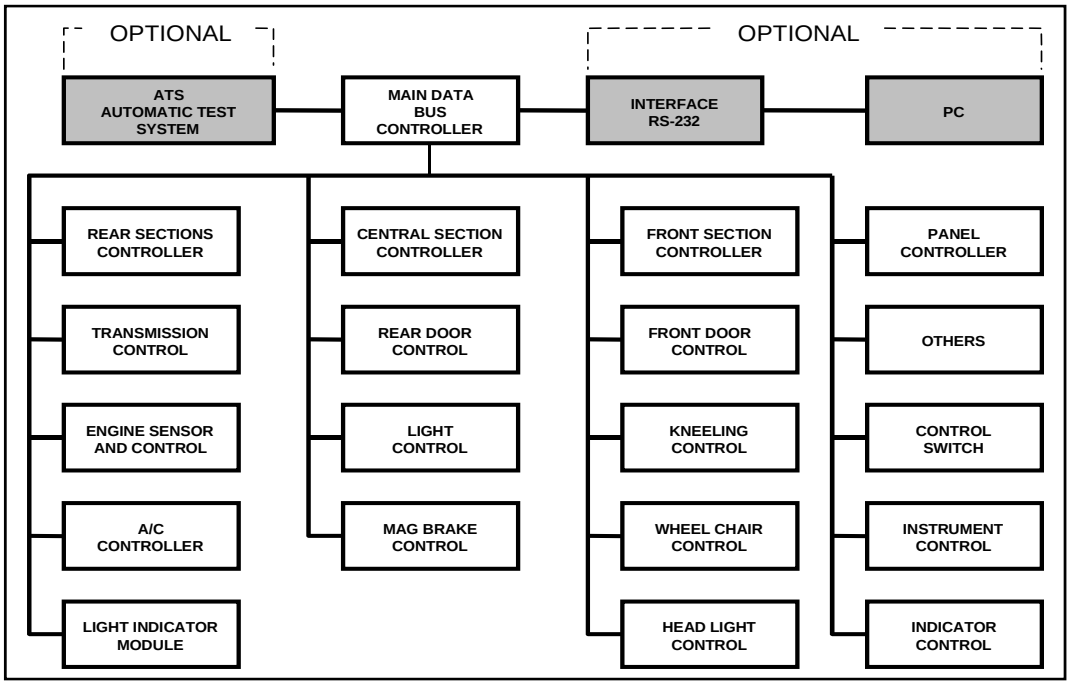
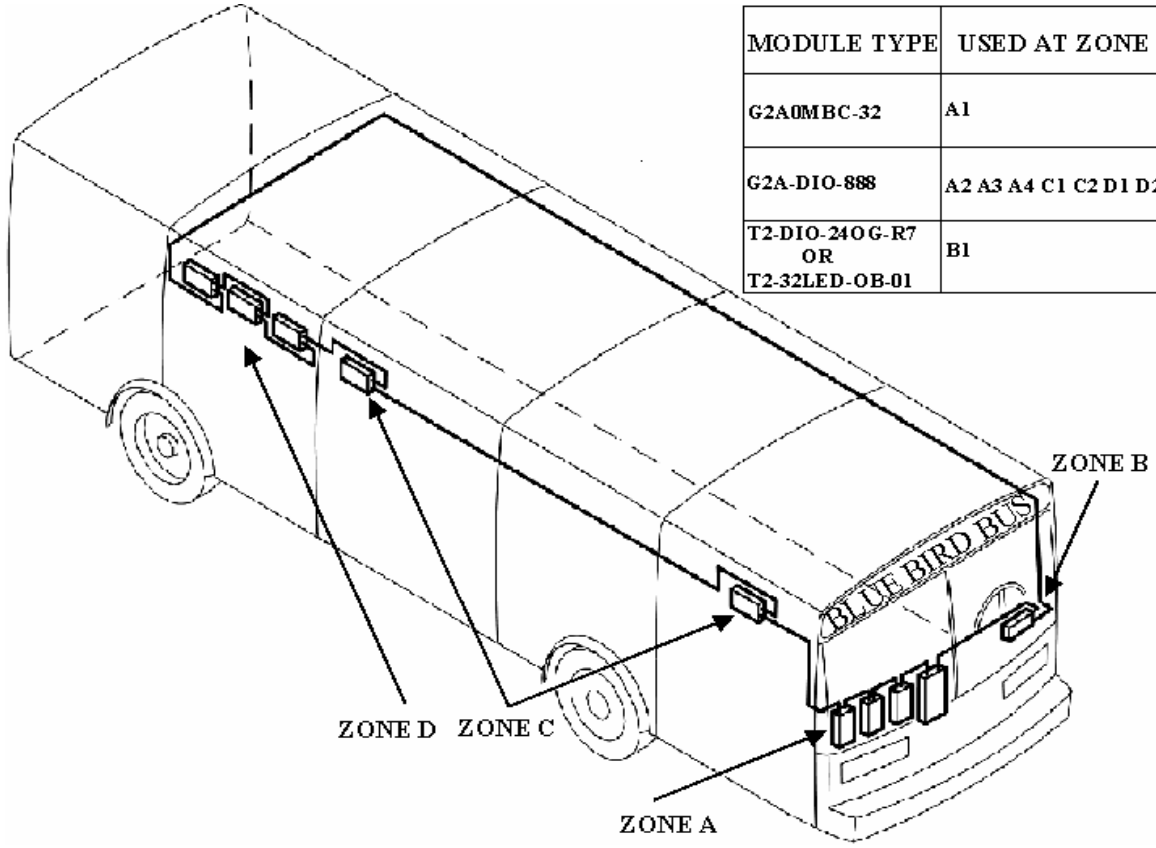


FIGURE: 2.1 – DINEX G2A SYSTEM

Typical Module Locations



(Some locations may vary due to customer options)

FIGURE: 2.2 – TYPICAL MODULE LOCATIONS

Modules are located in zones as near to the needed inputs and outputs as possible. The locations of the modules reduce the amount of “hard” wire necessary to reach the module. Some examples of zone locations are:

Zone A Door Area/ Main Panel
Zone B: Above Driver
Zone C: Front Door / Rear Door
Zone D: Engine Area

- How the DINEX G2A System Works?
- Main Data Bus Controller with PMS Module: G2A-MBC-32
- Intelligent Digital Input/Output Control Module: G2A-DIO-888
- Intelligent Digital 24 Output GW module: T2-DIO-24OG-R7
- 32 LED Indicator Panel: T2-32LED-OB-01

3

Introduction To System Components

How the DINEX G2A System Works?

The inputs to the Main Bus Controller (MBC) Module are supplied by the driver operated controls and the various switches and sensors linked together in the system.

G2A-MBC-32 module can receive up to 32 inputs. It does not have outputs and feedback channels.

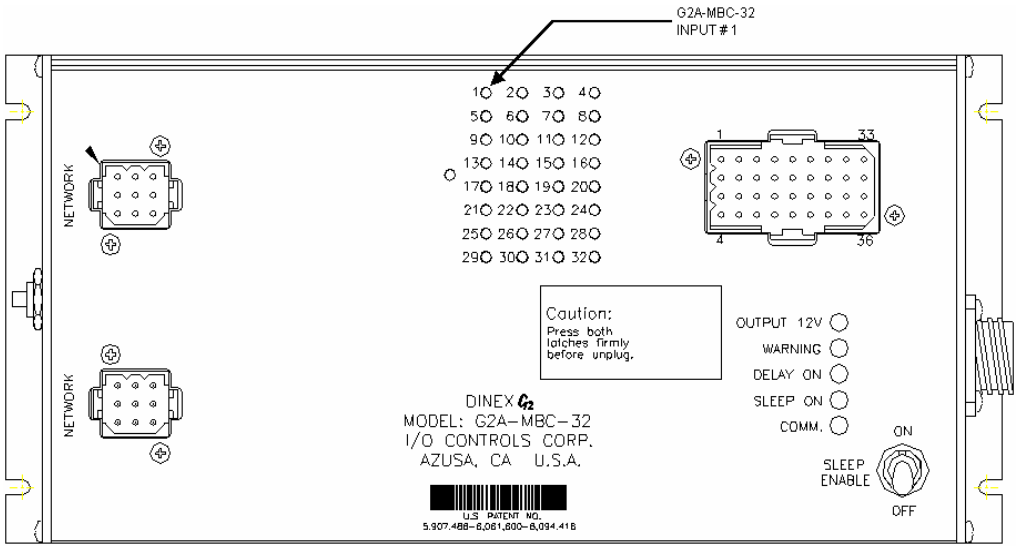


FIGURE: 3.1 -- G2A-MBC-32

When the driver turns on a switch, the inputs are activated and a signal goes to the MBC.

The MBC is the COMMAND CENTER or the switchboard.

The MBC receives inputs as an on or off signal and relays the signal to the module that executes the commands. After the module executes the command it keeps track of how the system is working. Each module in the system has a unique address.

The MBC uses the DATA CABLE to link up with the various modules required to do the job.

The DATA CABLE is made up of eight, small gauge wires. The twist pair wire keeps out all unwanted noise that might distort the data. Data travels through the cable at 115,200 BPS or 1/1,000,000th of a second.

The DATA CABLE talks to all components through a unique “loop” link-up. The MBC checks in with each module and issues instruction. As a check, it rechecks its inputs to verify that the job has been done.

LEDs tell the driver/operator if the modules are working as he has instructed. Single-controller systems are used in the Data Bus Cable. MBC is the only controller in a system and is the only programmable module among the system components.

The Main Bus Controller (MBC) is the general-in-command. It has the special built-in features, such as a computer, which tells all listeners what to do. After the MBC issues a command it tracks the work in progress.

The MBC communicates all instructions via a data cable to all modules in the network. Each module is identified by an address, like an employee, social security, or phone number. The MBC contacts modules by using this special ID number.

G2A-MBC-32 module can receive up to 32 inputs. The G2A-MBC-32 module does not have outputs and feedback channels.

Multiplex modules are each assigned a unique address. This address allows the MBC to communicate directly with each specific module. Each module has a sub-address that relates to a specific circuit.

Most DIO modules can control up to eight output circuits and receive eight more inputs, and, optionally, 8 feedback channels.

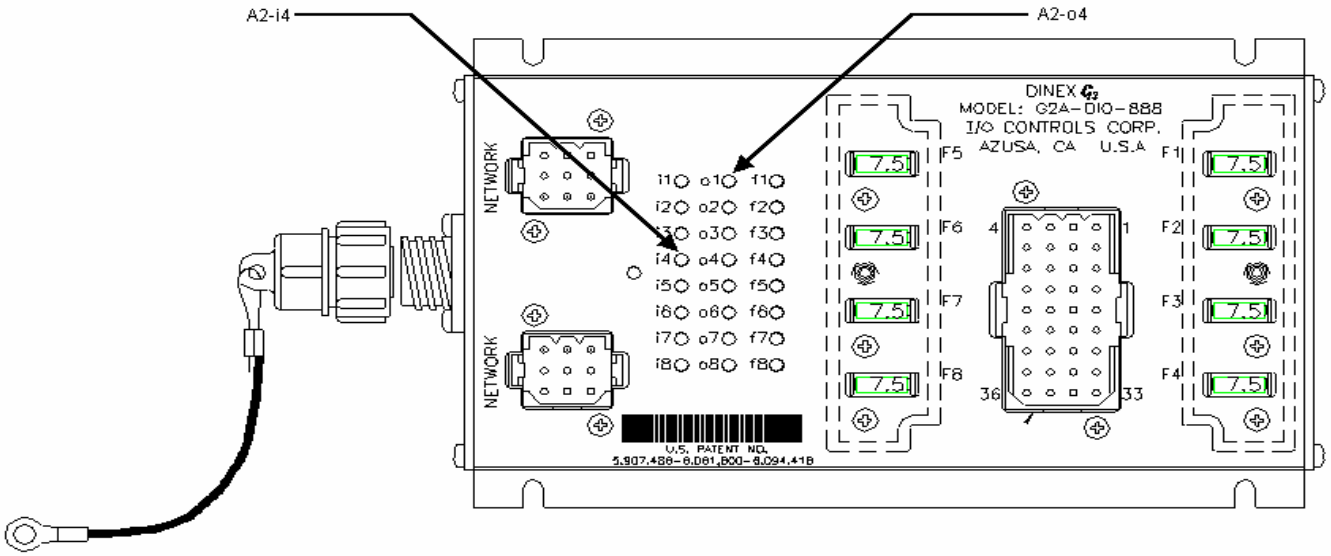


FIGURE: 3.2 -- G2A-DIO-888

For example, in the figure of G2A-DIO-888 above,

A = module location on the bus
4 = module number
i4 = input point on the module

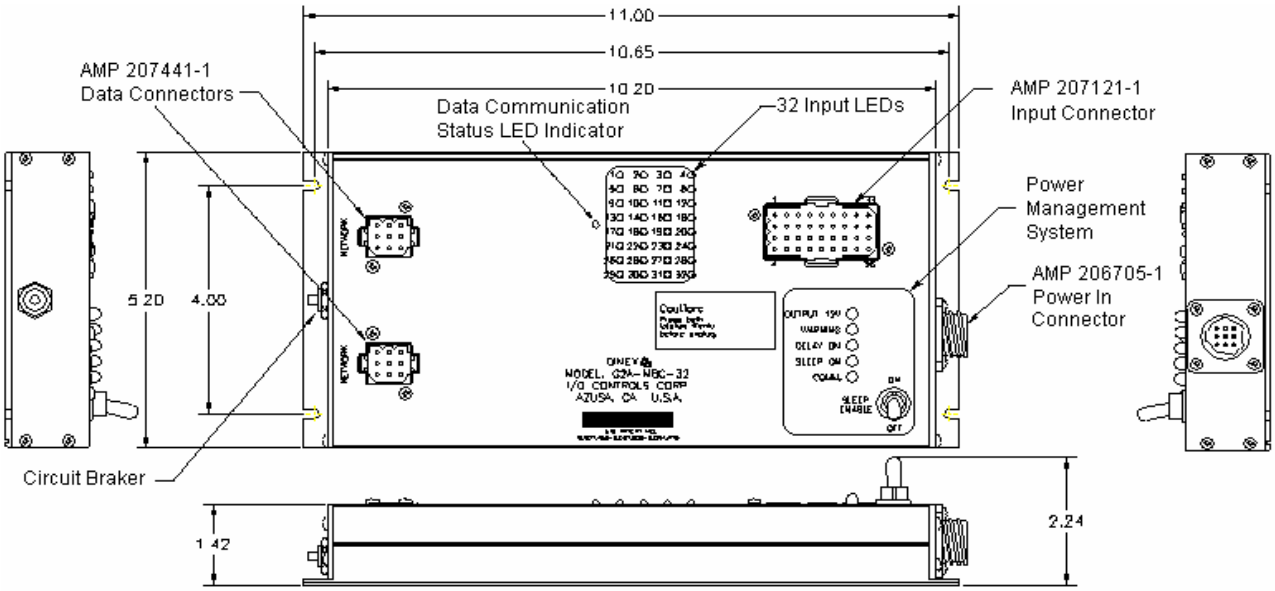
Thus, MBC-1 = input from master switch/run position
A2-i4 = input from interlock stop light pressure switch
A2-o1 = output to stop light lamps

The loop and how it works:

The MBC uses the main data bus cable to communicate with all the modules in turn, one after the other.

The MBC only addresses each module -- using its unique address -- one at a time, telling it what to do and then the MBC rechecks its inputs to verify the job has been done as ordered.

The Main Bus Controller with PMS Module
G2A-MBC-32



AMP 207441-1	
1	DNET-A
2	DNET-B
3	+VIN
4	GROUND
5	CNET-A
6	CNET-B
7	PROG_L
8	RESET_L

AMP 206705-1	
1	12V (+)
2	12V (-)
3	RESERVED
4	WARNING OUTPUT
5	MASTER SW POS. 6
6	A 485
7	B 485
8	GND
9	BATTERY 24V

AMP 207121-1	
1-32	INPUT 1-32
33	COM1 FOR INPUT 1-16
34	COM2 FOR INPUT 17-24
35	COM3 FOR INPUT 25-28
36	COM4 FOR INPUT 29-32

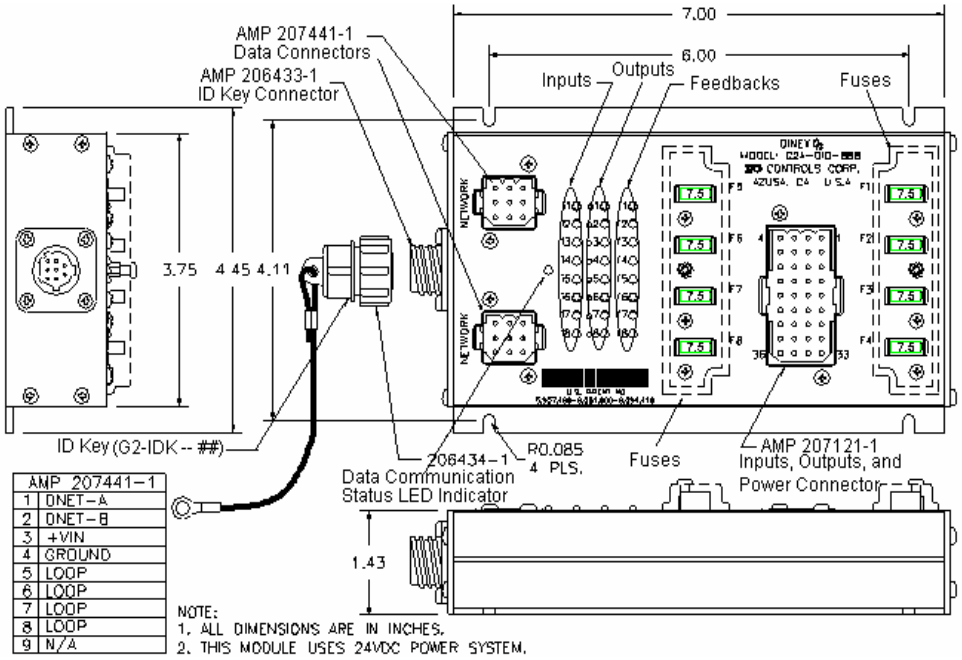
NOTE:
1. ALL DIMENSIONS ARE IN INCHES.
2. THE CAVITY ON THE SLEEP ENABLE SWITCH NEEDS TO BE FACING UP IN THE ON POSITION.

FIGURE: 3.3 -- G2A-MBC-32 MODULE DIAGRAM

The Main Bus Controller – G2A-MBC-32 -- is the top-level device. It is the command post for what's happening throughout the operating system.

- The Main Bus Controller controls and monitors up to 16 modules in a single level of data bus.
- It interfaces with 32 inputs and contains its own power management unit for entire system.
- It interfaces with switches, such as limit switches, temperature and pressure switches, and can directly control other modules.
- LED status indicators are provided on all input points.
- It stores instructions for control and monitor.
- It supports Automatic Test Equipment.
- All I/O points are optically isolated.
- It replaces relays with solid state, electrical switching.
- The MBC is simple to replace in the field.
- It has Built-In Self Test functions in software.

Intelligent Digital Input/Output Control Module G2A-DIO-888



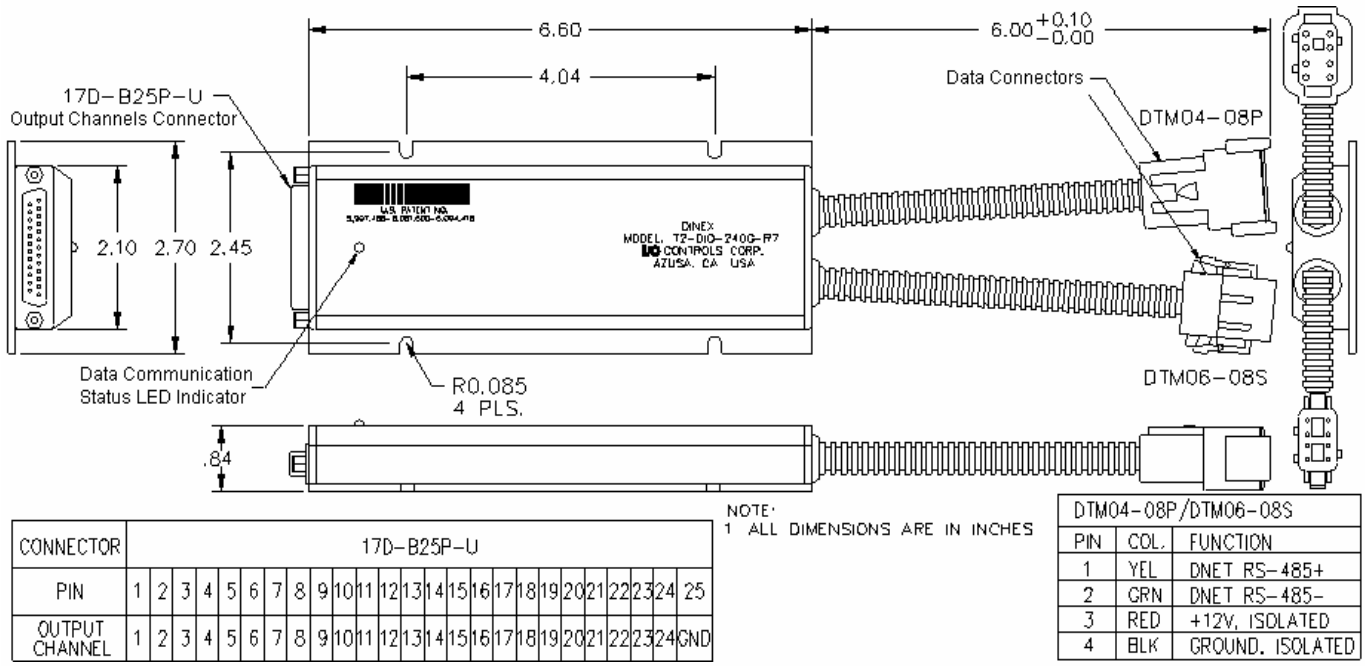
AMP 207441-1	
1	DNET-A
2	DNET-B
3	+VIN
4	GROUND
5	LOOP
6	LOOP
7	LOOP
8	LOOP
9	N/A

AMP 207121-1		
PIN	SOURCE OUTPUT CONNECTION	SINK OUTPUT CONNECTION
1,2	CH 1 POWER	CH 1 OUTPUT
5,6	CH 1 OUTPUT	GROUND
9,10	CH 2 POWER	CH 2 OUTPUT
13,14	CH 2 OUTPUT	GROUND
17,18	CH 3 POWER	CH 3 OUTPUT
21,22	CH 3 OUTPUT	GROUND
25,26	CH 4 POWER	CH 4 OUTPUT
29,30	CH 4 OUTPUT	GROUND
4	CH 5 POWER	CH 5 OUTPUT
8	CH 5 OUTPUT	GROUND
12	CH6 POWER	CH 6 OUTPUT
16	CH 6 OUTPUT	GROUND
20	CH 7 POWER	CH 7 OUTPUT
24	CH 7 OUTPUT	GROUND
28	CH 8 POWER	CH 8 OUTPUT
32	CH 8 OUTPUT	GROUND
33	GROUND	GROUND
34	POWER 24V	POWER 24V
3	INPUT 1	INPUT 1
7	INPUT 2	INPUT 2
11	INPUT 3	INPUT 3
15	INPUT 4	INPUT 4
19	INPUT 5	INPUT 5
23	INPUT 6	INPUT 6
27	INPUT 7	INPUT 7
31	INPUT 8	INPUT 8
35	INPUT COMMON	INPUT COMMON
36	N/C	N/C

FIGURE: 3.4 -- G2A-DIO-888 MODULE DIAGRAM

- DIO normally can only handle 8 inputs, 8 feedbacks and 8 outputs.
- Special DIO units allow additional input controls (up to 32 inputs total).
- Replace like devices with like devices. READ THE LABELS first before replacing one unit with another.
- DIOs are on/off units only and are not programmable.
- Feed-back circuits are used for BIST (Built-In Self Test)

Intelligent Digital 24 Outputs Gateway Module
T2-DIO-24OG-R7



CONNECTOR	17D−B25P−U																								
PIN	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
OUTPUT CHANNEL	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	GND

DTM04−08P/DTM06−08S		
PIN	COL.	FUNCTION
1	YEL	DNET RS−485+
2	GRN	DNET RS−485−
3	RED	+12V, ISOLATED
4	BLK	GROUND, ISOLATED

FIGURE: 3.5 -- T2-DIO-24OG-R7 MODULE DIAGRAM

- For driving LED modules.
- Total 24 outputs
- LEDs on the instrument panel are the outputs.
- Acts as gateway on DINEX network and other host systems.

32LED Indicator Panel
T2-32LED-OB-01

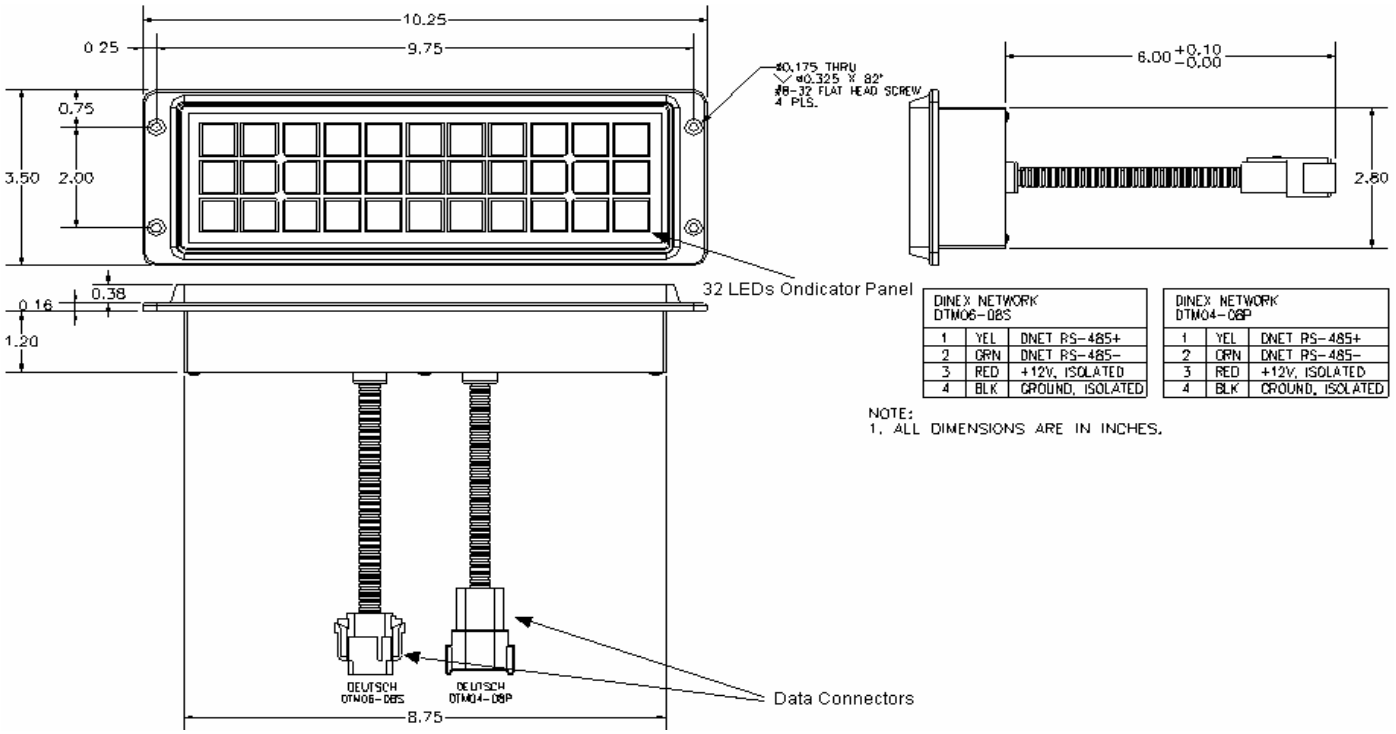


FIGURE: 3.6 -- T2-32LED-OB-01 PANEL DIAGRAM

- Instrument Panel LEDs are multiplexing modules.
- Total 32 LED indicators.
- LEDs on the instrument panel are the outputs.
- Each indicator contains multiple LED elements.
- The LED cluster can be removed/replaced as a unit or LEDs can be removed/replaced individually.
- Replacement LEDs are not labeled (each label is a separate piece).
- First indication that an LED is failing maybe a dimming of the LED.

4

- **Dinex G2A System "Tree" Structure**
- **Dinex G2A System Ring-Loop Hookup Structure**
- **Dual Voltage Capability**

How Is It All Hooked Together ?

Dinex G2A System "Tree" Structure

The Dinex G2A System "Tree" hierarchy and data bus layout is shown below:

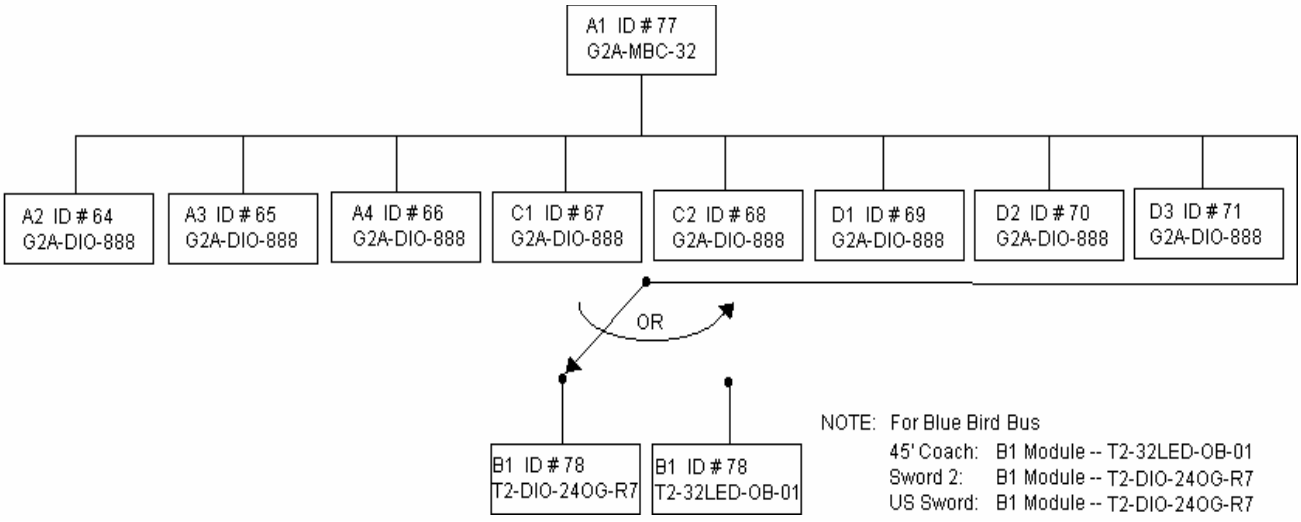


FIGURE: 4.1 – DINEX G2A SYSTEM "TREE" STRUCTURE DIAGRAM

G2A-MBC-32 = MAIN BUS CONTROLLER MODULE WITH PMS
G2A-DIO-888 = DIGITAL INPUT/OUTPUT MODULE
T2-DIO-24OG-R7 = 24 OUTPUTS GATEWAY MODULE
T2-32LED-OB-01 = DASHBOARD LAMP CLUSTER OR TELL-TALE PANEL

Dinex G2A System Ring-Loop Hookup Structure

The Dinex G2A System – Ring-Loop Hookup Structure shown below:

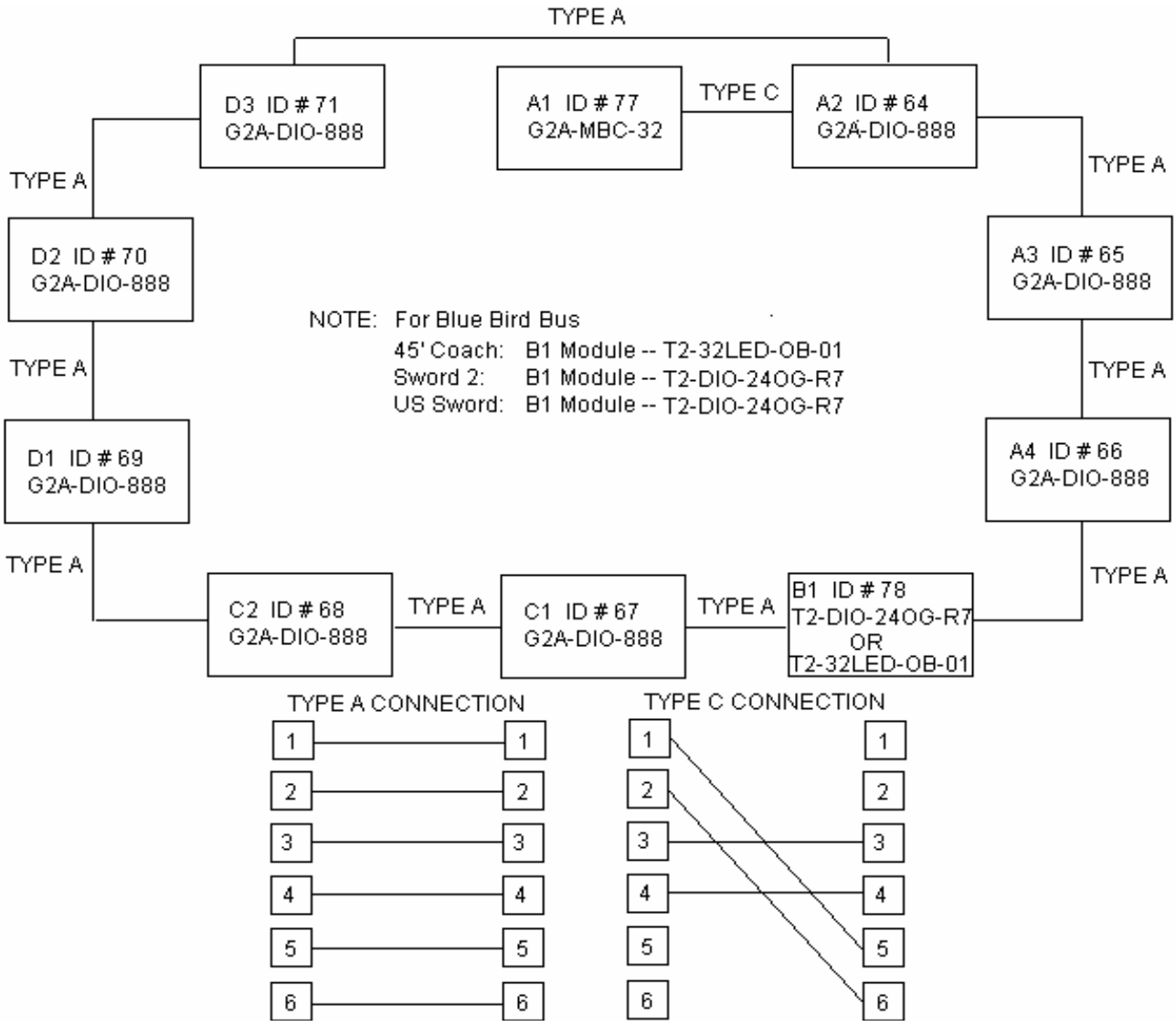
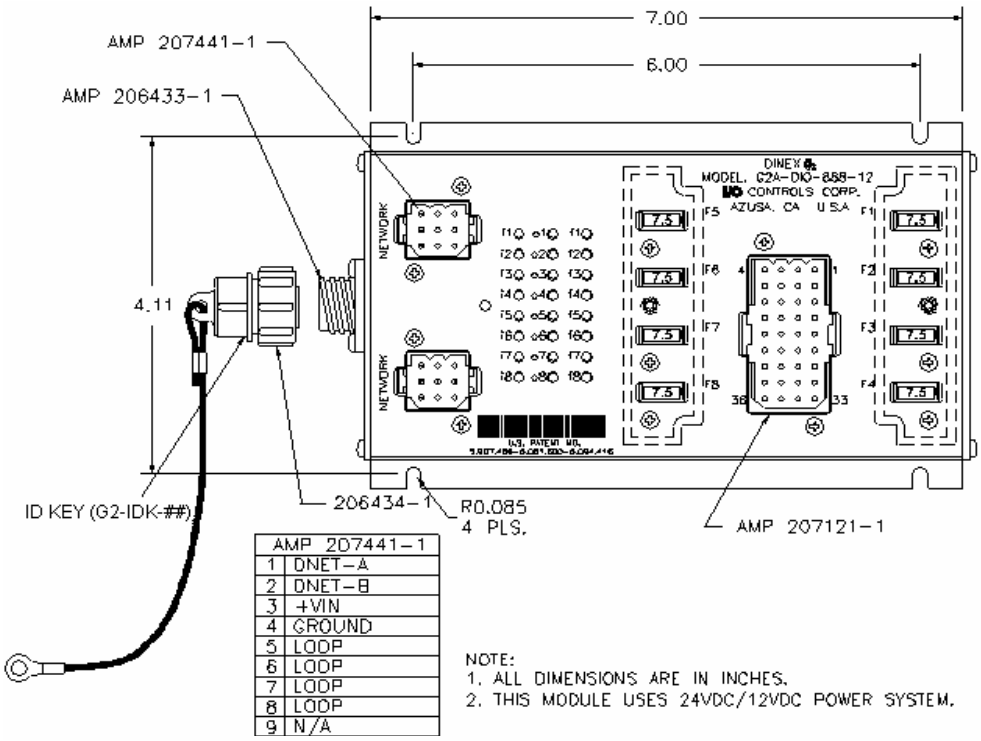


FIGURE: 4.2 – DINEX G2A SYSTEM RING-LOOP HOOKUP DIAGRAM

Dual Voltage Capability



AMP 207441-1	
1	DNET-A
2	DNET-B
3	+VIN
4	GROUND
5	LOOP
6	LOOP
7	LOOP
8	LOOP
9	N/A

NOTE:
1. ALL DIMENSIONS ARE IN INCHES.
2. THIS MODULE USES 24VDC/12VDC POWER SYSTEM.

AMP 207121-1		
PIN	SOURCE OUTPUT CONNECTION	SINK OUTPUT CONNECTION
1,2	CH 1 POWER	CH 1 OUTPUT
5,6	CH 1 OUTPUT	GROUND
9,10	CH 2 POWER	CH 2 OUTPUT
13,14	CH 2 OUTPUT	GROUND
17,18	CH 3 POWER	CH 3 OUTPUT
21,22	CH 3 OUTPUT	GROUND
25,26	CH 4 POWER	CH 4 OUTPUT
29,30	CH 4 OUTPUT	GROUND
4	CH 5 POWER	CH 5 OUTPUT
8	CH 5 OUTPUT	GROUND
12	CH6 POWER	CH 6 OUTPUT
16	CH 6 OUTPUT	GROUND
20	CH 7 POWER	CH 7 OUTPUT
24	CH 7 OUTPUT	GROUND
28	CH 8 POWER	CH 8 OUTPUT
32	CH 8 OUTPUT	GROUND
33	GROUND	GROUND
34	POWER 24V/12V	POWER 24V/12V
3	INPUT 1	INPUT 1
7	INPUT 2	INPUT 2
11	INPUT 3	INPUT 3
15	INPUT 4	INPUT 4
19	INPUT 5	INPUT 5
23	INPUT 6	INPUT 6
27	INPUT 7	INPUT 7
31	INPUT 8	INPUT 8
35	INPUT COMMON	INPUT COMMON
36	N/C	N/C

FIGURE: 4.3 – INPUTS, OUTPUTS, & POWER CONNECTION DIAGRAM

NOTE: When removing wires from panel power studs, be sure to tag and reinstall removed wires to the same location.

- DIO modules have split circuits to allow two different output circuit voltages (12 or 24 volts) from a single module.
- Power can be 12/12, 12/24, 24/12, 24/24 volts depending on the voltage requirements of circuits being controlled.
- Pin #35 supplies power to the eight inputs.
- "Inputs" to the multiplex system are grounded at a switch.
- Ground wire is in the AMP type connector PIN # 33

Dual Voltage Capability

5 Diagnosis and Troubleshooting

- Three Basic Steps to Diagnosis and Troubleshooting
- Visual Inspection
- BIST (Built-In Self Test)

Diagnosis and Troubleshooting

The DINEX G2A system is composed of a network of rugged modules connected to a single data bus. This data bus interfaces with DINEX G2A modules. The DINEX G2A modules interface with sensors, switches, actuators and vehicle control devices.

The simplified wiring of the DINEX G2A network control system makes troubleshooting relatively simple in most cases.

Three Basic Steps to Diagnosis and Troubleshooting:

- Visual Inspection
- I/O Test Kit Verification
- Software Testing and Programming
- BIST (Built-In Self Test)

1. Visual Inspection

Eighty-five percent of failed circuits can be diagnosed by using modules' LEDs -- failures usually related to defective parts, i.e., bulbs, switches, etc. This chapter discusses in depth how to diagnose and troubleshoot through visual inspection

2 I/O Test Kit Verification

Note: If the three steps fail to locate or solve the faults, then the module is suspect. The module must be returned to the manufacturer for repair.

No internal repairs are permitted unless authorized by the factory.

The I/O Control Test Kit provides for the testing of modules and the communication network. The I/O Control Test Kit will assist you in diagnosing those faults not found during visual inspection. *The next chapter will introduce these test kits in more details.*

3. Software Testing and Programming

Software Testing provides a way of verifying module programming or programming of replacement modules. *Please refer to bus manufacturer's control logic diagrams/ladder charts for software testing and programming.*

4. BIST (Built-In Self Test)
The BIST may be invoked any time. It is a passive test which uses the feedback circuits to check the output circuits. It also checks the DINEX module communications.

Visual Inspection:

- Visual inspection of the LEDs on the DINEX G2A modules will normally lead to the identification of 85% of all faults.
- Use Ladder Logic Diagrams -- to identify the relationship and the hook-up of devices -- and,
- Electrical Schematics -- to trace the circuits linked to a malfunctioning module indicated by the LED -- is all that is required at the Visual Inspection Level.
- Input Circuit LEDs.
- Ground connection – Verify that pin 16 of the large round AMP connector has a good chassis ground connection.

All modules, except PMS and junction boxes, have green LEDs to monitor input circuits. Each input has its own address. The lighted green LED indicates active input

Note: Some vehicle options -- such as mirror heaters, air dryers, etc.-- will not turn on the amber LED until a preset temperature is reached.

LED marker lights will not turn on the amber LED's at all.

- Output Circuit LEDs

DIO-888s use two LEDs, amber and red, to monitor output. If the circuit is off, the amber LED is lighted. The circuit is complete and ready, but is not active.

A lighted red LED indicates that the circuit is active.
The amber LED is off.

- Using LED on the modules to diagnose failed components.
- The "tools" necessary to diagnose faults are LEDs on the modules, "Ladder Charts" (or logic diagrams) and Electrical Schematics.
- When an LED does not indicate proper circuit operation, the electrical schematic can be used to trace the circuit from the module(s) to the input or output.
- Multiplex Test Equipment, Step 2, should not be necessary until, and only until, visual inspection has failed to indicate the failure or to confirm the functionality of the operation.

Checking the Input LEDs

- The MBC and DIO modules have green LEDs to monitor all inputs.
- Each input point has a unique location or sub-address. When the green LED is on, the input is ACTIVE.

LEDs Monitor Circuits

NOTE: During normal operation, the red and amber LEDs alternate off and on.

- With the circuit turned off: An amber LED comes on. (The amber LED indicates circuit integrity.) A circuit is complete and ready, but IT DOES NOT MEAN THE CIRCUIT IS ACTIVE.
- When the circuit is in use: A red LED will come on. This indicates that the circuit is ACTIVE. The amber LED turns off.

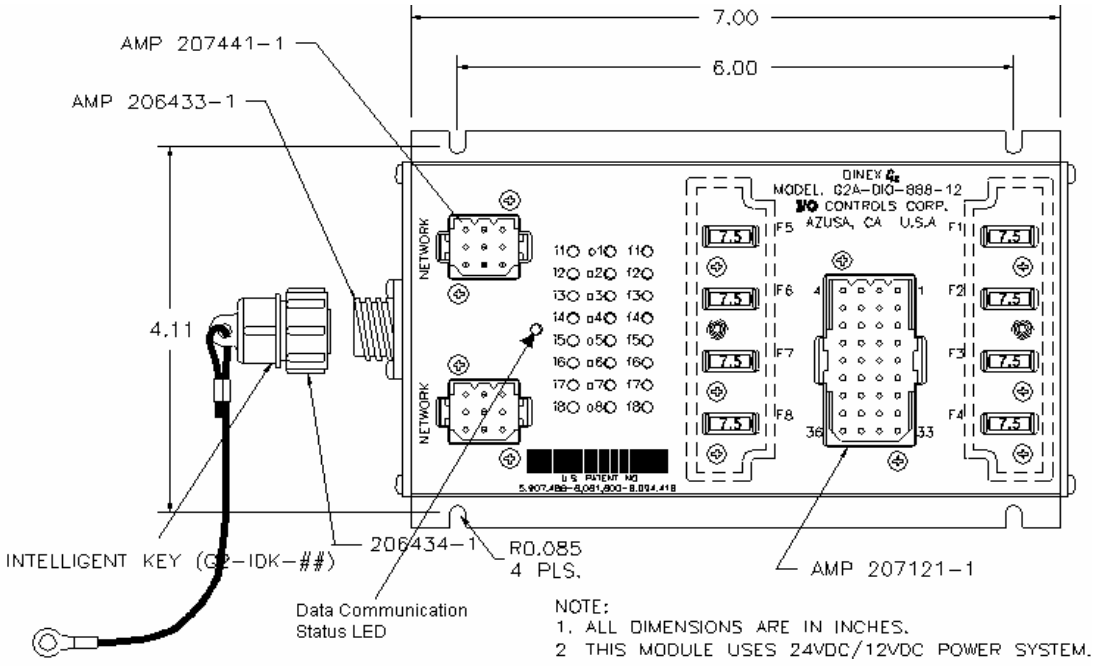


FIGURE: 5.1 – DATA COMMUNICATION STATUS LED DIAGRAM

The Data Communications Status LED

NOTE: On some models, according to specification of each particular customer, the Data Communication Status LED is located on the left side panel of the module.

- The MBC, and DIO modules have Data Communications Status LED mounted on the left side of the face of the module, as shown in the figure above for a DIO module.

- The Data Link LED flashes at a rapid rate to indicate that the module is communicating.
- Modules in communication with DIOs respond with flashing LEDs. When multiple circuits respond, check the Data Link LED to see if it is flashing.

Tips on locating the site of a Failure using LEDs on the DIO modules

- If the load circuit is open -- i.e., bulb blown, burned solenoid, broken wire, etc.—the amber LED will not light up.
- If both amber and red LEDs are on when the circuit is active, check the fuse.
- If a module's red LED is out,
    a) check the data communication status LED on the left side of the module
    b) check cable for loose connections or damage,
    c) or check the related input status.

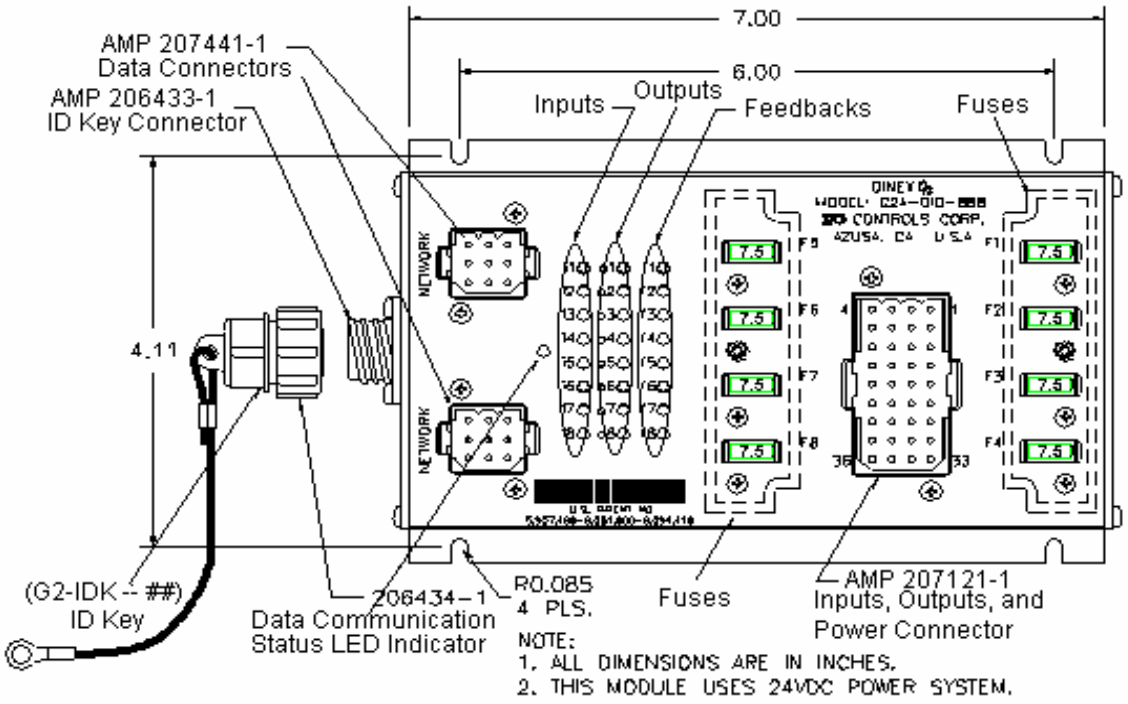


FIGURE: 5.2 –LEDS VISUAL INSPECTION DIAGRAM

Tips on locating the site of a Failure using LEDs on the DIO modules

- Internal circuits in the multiplex units (DIO) allow a small amount of current to flow to the output load -- even when the load is inactive.
- Current from the battery bus bar will pass through the amber LED, a large resistor, and the load to get to ground.
- A blown fuse will still allow current to flow through the amber LED and the red LED will be on because the circuit is trying to activate itself.

The No Connection Circuit

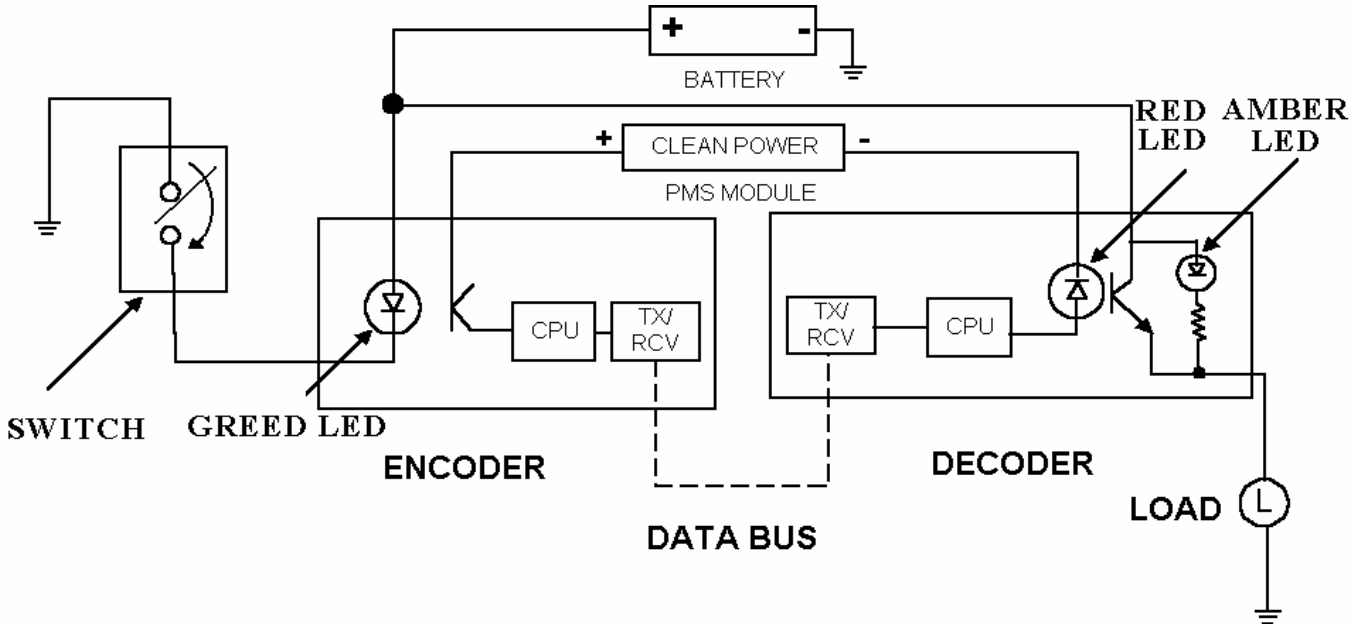


FIGURE: 5.3 – FUNCTIONAL DIAGRAM OF DINEX MPX SYSTEM

- The simplified circuit on the previous page shows that there are no direct links among input, the data bus, and the output.

  -The green LED turns on the sensor and switch inputs.

  -A light sensing (solar) transistor closes and a CPU sends out a signal on the data bus.

  -The receiving CPU lights the red LED.

  -Another light sensing transistor closes and completes the circuit from the battery to the load.
- No direct wire links eliminates the need for external diodes.
- Danger of voltage spikes damaging the data loop or modules is eliminated.

LADDER CHARTS

Understanding the Ladder Charts

Think of ladder charts as logic diagrams, see below:

Active And Inactive Inputs

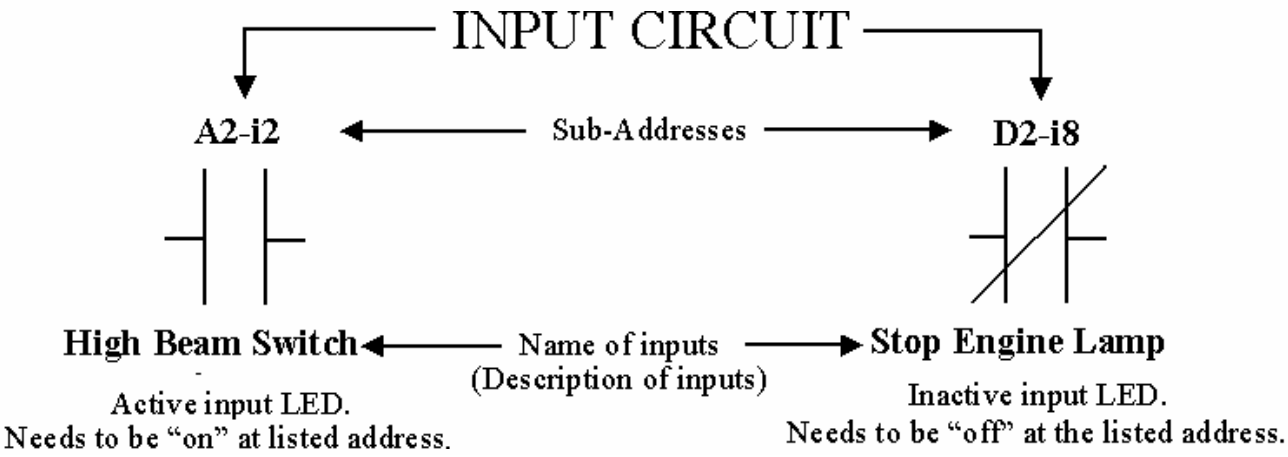


FIGURE: 5.4 – ACTIVE & INACTIVE COMPONENT DIAGRAM

- The MBC can be programmed to use open (inactive) or closed (active) switch input to determine a course of action.
- Imagine a relay that is normally open. Imagine the LED as a relay coil:

  -With no power to the relay, the LED is off. The relay is in the normally open position.

  -When power is applied, the LED is on and the relay is in the closed position. The current flows through the control load.

About Ladder Charts

- Simple charts make diagnosing circuits easy.
- All conditions must be met to complete an action.
- Charts indicate any parallel circuits for an action.

What Do Ladder Charts Look Like?

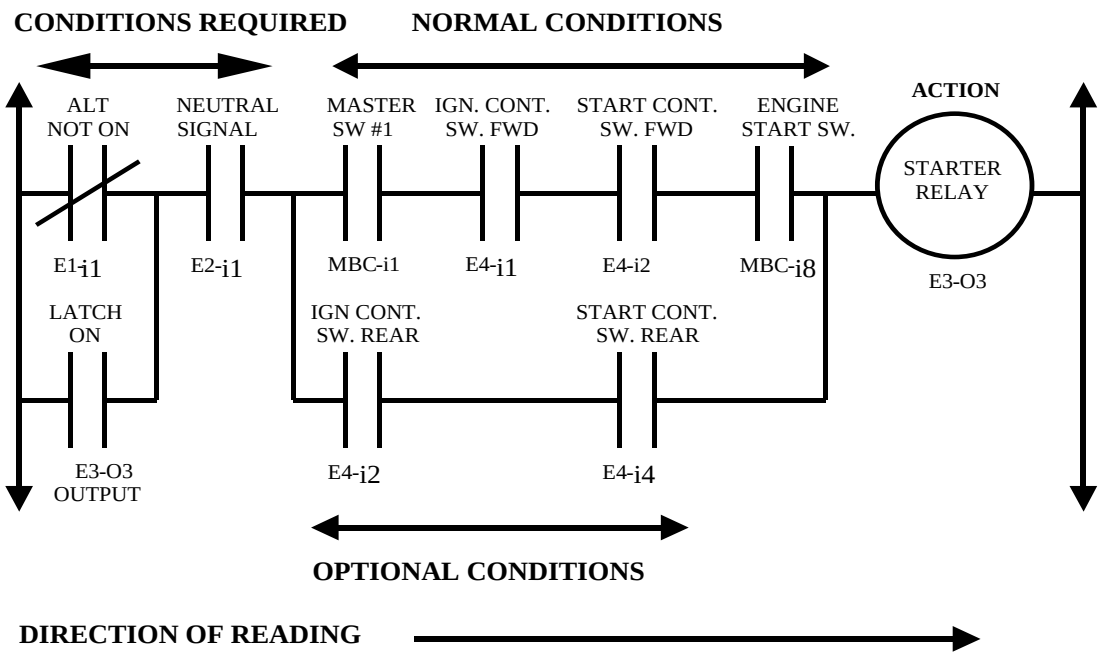


FIGURE: 5.5 – LADDER CHARTS DIAGRAM

More About Ladder Charts

- The Ladder Chart above shows each step necessary for a vehicle to be started.
    1. The alternator must not be charging.
    2. Vehicle is in neutral.
    3. From the front -- the master switch is on.
    4. From the rear -- the rear ignition and starter switches may be used.
    5. From the rear -- the ignition and starter control switches are set in front start position.
    6. Use the starter button.
    7. "Latch On" function circuit is set for starter relay.
        a. Circuit remains complete as long as starter is cranking, even if alternator starts to charge.
        b. Starter can not be re-engaged if alternator is charging.

BIST (Built-In Self Test)

On the buses, the 'Left Turn' and 'Right Turn' lamps on the Dashboard LED display can display a flash code if there is any Dinex module communication failure or Output Feedback problem. These are generally known as BIST flash codes, for Built In Self Test. The Right Turn, Left Turn, and Diagnostic Light Test switch must all be on at once in order to begin a flash code cycle.

Once begun, the flash code sequence will go through and check all of the modules, so there is no need to hold all three switches continuously. The flash code sequence will cycle again if the three switches are on, otherwise the BIST sequence will check each module and then stop. The warning buzzer is usually on when the Diagnostic Light Test switch is on, but the buzzer is silenced during the BIST. If there is no BIST failure, then the warning buzzer will sound periodically while all three switches are held on and neither the Left Turn nor the Right Turn dashboard lamp will light.

The Right Turn lamp on the Dashboard LED display will flash quickly to show which module has a failure. The Left Turn lamp will flash slowly to show which output channel(s) from the failed module is actually bad. If the Left Turn lamp does not flash, then this indicates a module communications failure rather than an output failure.

RIGHT TURN Lamp is:	Meaning
Off	Dinex module is OK
One Flash	Module A2 #64 Fault
Two Flashes	Module A3 #65 Fault
Three Flashes	Module A4 #66 Fault
Four Flashes	Module C1 #67 Fault
Five Flashes	Module C2 #68 Fault
Six Flashes	Module D1 #69 Fault
Seven Flashes	Module D2 #70 Fault
Eight Flashes	Module D1 #71 Fault
14 Flashes	Module A1 (MBC) #77 Fault (internal)
15 Flashes	Module B1 #78 Fault
9 - 13, or 16 Flashes	Incorrect Dinex program, Incorrect Accessory (Palm PC).

LEFT TURN Lamp is:	Meaning
Off	Nothing (Or Communication Fail)
One Flash	Module output #1 failure
Two Flashes	Module output #2 failure
Three Flashes	Module output #3 failure
Four Flashes	Module output #4 failure
Five Flashes	Module output #5 failure
Six Flashes	Module output #6 failure
Seven Flashes	Module output #7 failure
Eight Flashes	Module output #8 failure

6

- **T2-MK-808 Test Kit**
- **T2-MK-Program Test Kit**

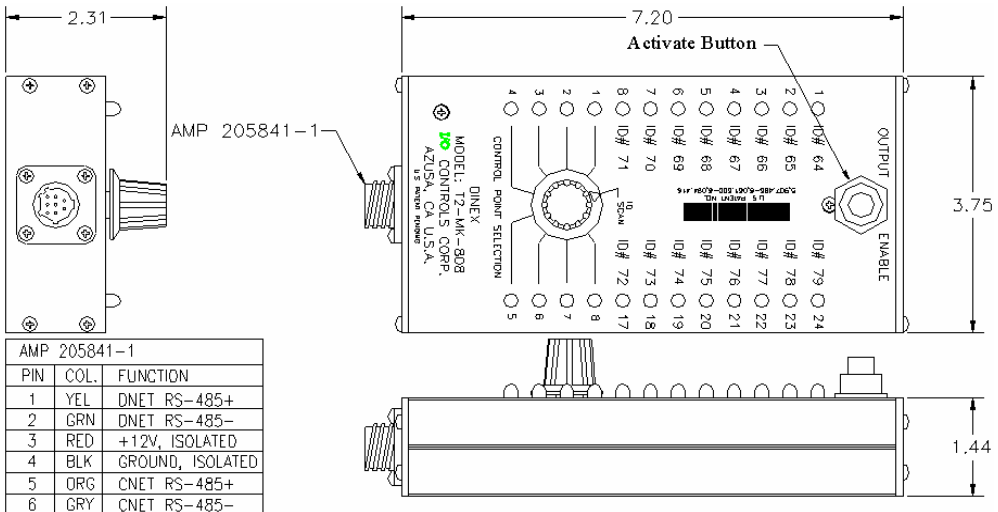
Testing Tools

G2A-MK-808 Test Kit

General Description

G2A-MK-808 is designed to diagnose and test G2A-DIO-888-K modules to support first line maintenance personnel. It is capable of testing the communications network function and simulating the direct output control of individual output point and monitor input status. It is also designed to check and support the integrity of the network. It does this by monitoring and scanning the ID of each network node. The versatility of G2A-MK-808 makes it the primary tool of the DINEX-G2A-MPX system.

Warning: ONLY AUTHORIZED AND TRAINED PERSONNEL SHALL USE THIS EQUIPMENT. The T2-MK-808 will override all safety preconditions. Mishandling may prove hazardous and harmful to the operator or third party. Special caution and authorization are required to operate this tool.



AMP 205841-1		
PIN	COL.	FUNCTION
1	YEL	DNET RS-485+
2	GRN	DNET RS-485-
3	RED	+12V, ISOLATED
4	BLK	GROUND, ISOLATED
5	ORG	CNET RS-485+
6	GRY	CNET RS-485-
7	PPL	PROGRAM
8	BLU	RESET

FIGURE: 6.1 – G2A-MK-808 MODULE DIAGRAM

G2A-MK-808 Tests DIO 888 Modules

- Tests communications network,
- Simulates outputs,
- Monitors inputs.

Target Device

G2A-DIO-888, and the network.

Major Test Component and Accessories

- G2A-MK-808
- I/O cables and ID Scan cable

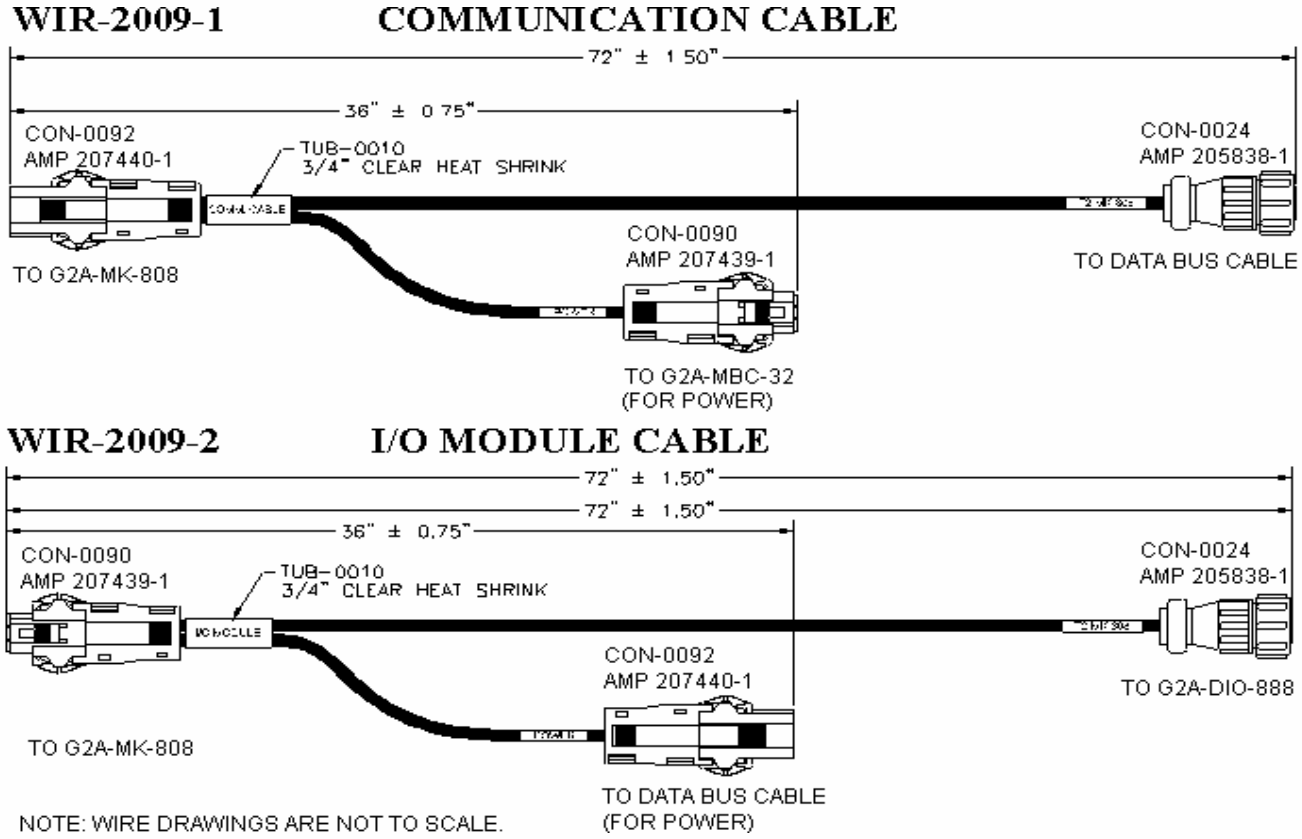


FIGURE: 6.2 – G2A-MK-808 CABLES DIAGRAM

Operating Procedure

Module ID and Input/Output Test

1. Power up the vehicle battery. Ensure that the MBC's PMS is in "wake up" mode to provide isolated power to DINEX G2A system.

2. Turn the dial on the G2A-MK-808 to "IDSCAN" position.

3. Disconnect both data bus cable connectors from the target module.

Note: *Make sure that the module is connected to the tester cable first and removed last at the end of testing.*

4. Connect the test cable ('I/O Modules' Cable) to target test module Connect (G2A-DIO-888) by following cable markings, i.e. connect the "I/O Modules" side of the test cable to the data side of module, connect the "Power" side of the test cable to either of the disconnected data cable connectors.

5. Target module's ID will now light up the corresponding LED on the tester.

6. Rotate the tester's dial to select the target output channel (1 through 8).
    i. -Push the activate button to activate the selected output.

    ii. -Repeat for different output channels.

7. At the same time the module input LEDs on the tester will light on or off corresponding to the module input status.

8. Check the activation status of the target module and the corresponding output point and input to verify the function and circuit integrity.

    i. -Outputs - If the red LED on the module does not come on during the test of a selected output, the module or connection is suspect.

    ii. -Inputs - If an input LED on the module is lit and the corresponding LED on the tester fails to light up, the module or connection is suspect.

    iii. –A bad or open ground on the large AMP connector pin 23 can prevent proper module operation.

Network Integrity Test

1. Disconnect the Y cable used for I/O module test from the G2A-MK-808.
   (Reconnect the I/O Module to the ring loop)

2. Replace the Y cable with another Y cable that is marked ‘Comm. Cable’ for Network test onto the G2A-MK-808. Follow the cable markings.

3. Disconnect both data cables from the G2A-MBC-32.

4. Set the select switch on the G2A-MK-808 to ID Scan.

5. Connect G2A-MK-808 cable to the connector of MBC data bus.

6. The corresponding tester LED should illuminate, indicating that the correct modules are connected to the main data bus.

7. Verify the network configuration and check integrity.

8. Reconnect both data cables back to the G2A-MBC-32.

T2-MK-PROGRAM Test Kit

General Description

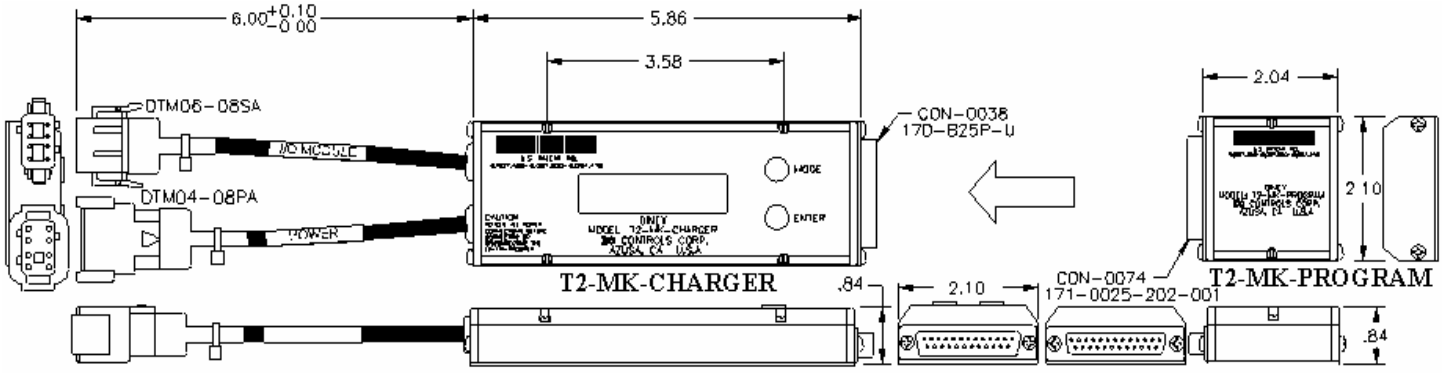
The PROGRAM KIT is designed to download program smoothly.

- T2-MK- PROGRAM holds program memory.
- T2-MK-CHARGER-R2 loads the program to the target MBC module in less than 60 seconds.

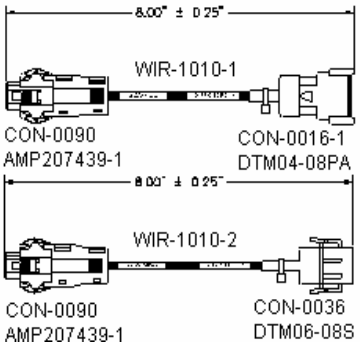
Module program changes (resulting from faults or updates) are easily corrected in the DINEX T2 system using the T2-MK-PROGRAM and T2-MK-CHARGER-R2, see the illustration above. The Charger will download the program to the target MBC in less than 60 seconds.

The PROGRAM and CHARGER are intended to be used as a pair without the aid of any additional equipment.

The LED device on the T2-MK-CHARGER-R2 can be helpful to monitor the status of downloading a new program, or verifying the program currently in the module.



DTM04-08P/DTM06-08S		
PIN	COL.	FUNCTION
1	YEL	DNET RS-485+
2	GRN	DNET RS-485-
3	RED	+12V, ISOLATED
4	BLK	GROUND, ISOLATED
5	ORG	CNET RS-485+
6	GRY	CNET RS-485-
7	PPL	NC
8	BLU	NC



NOTE:
1. ALL DIMENSIONS ARE IN INCHES.
2. ALL CONNECTORS USE TUB-0003 3/4" BLACK HEAT SHRINK.
3. ALL CONNECTORS USE TUB-0016 PLASTIC TIE WRAP.
4. ALL CONNECTOR WIRES USE TUB-0002 1/4" BLACK HEAT SHRINK.
5. ALL WIRE LABELS USE TUB-0017 1/4" CLEAR HEAT SHRINK
WIRE DRAWINGS ARE NOT TO SCALE.

FIGURE: 6.3 – T2-MK-CHARGER & T2-MK-PROGRAM DIAGRAM

Target Devices

G2A-MBC-32

NOTE: *When replacing a new G2A-MBC-32 module, the same system unique program must be loaded to the new module as was used in the "old" system.*

When the control system needs customer design changes, the updated program or programs must be loaded to the specific G2A-MBC-32 module to ensure that the system performs as required.

Up-loading a program to T2-MK-PROGRAM kit from a PC (for Level 2 & Level 3 or Factory used only)

Operating Procedure

1. Prepare the PC-compatible computer with the T2-MK-232 (an RS232 to RS485 converter module) in normal programming mode.

2. Identify the target, G2A-MBC-32 module and verify the program to be downloaded.

3. Select the correct program to be downloaded.

4. Connect the T2-MK-CHARGER-R2 and the T2-MK-PROGRAM modules together via their DB-25 connectors.

5. Apply power to the T2-MK-CHARGER-R2 by connecting the 9-volt AC Power adapter supplied with the T2-MK-232 kit.

6. Select "Upload Mode" on the T2-MK-CHARGER and press ENTER

7. Execute the normal PC program upload/downloading procedure to upload:
    i. Select file to be uploaded
    ii. Select COM port
    iii. Select "G2A"
    iv. Select baud rate: 115K for G2A system
    v. Ignore the code length selection (It's fixed length: 3FFF in hexadecimal)
    vi. Press button called 'Program & Verify'

8. If an error message window is shown up, reset the CHARGER module by unplugging the power adapter. Plug it in again to reset the CHARGER. And repeat Step 6 again till a download completion message window is displayed.

9. Program download is now completed. The T2-MK-PROGRAM modules are ready for service.

Verifying or downloading the program <u>from</u> T2-MK-PROGRAM kit to the target module <u>IN THE VEHICLE</u>

Operating Procedure

1. Turn on the vehicle battery power.

2. Identify the target G2A-MBC-32 module and verify the program to be downloaded.

3. Choose the correct pre-loaded T2-MK-PROGRAM module to be downloaded.

4. Connect the T2-MK-CHARGER-R2 and the T2-MK-PROGRAM modules together via their connectors.

5. Connect the cable assembly via the 8-pin connector to target module, but disconnect the target module from the ring loop at both connections.

6. Select ‘Verify’ mode. By pressing ‘Enter’ button, it starts to verify the program in the PROGRAM module and the program in the target module.

7. If the ‘Verify’ OK, they both contain an identical program. The CHARGER will display ‘checksum’ and ‘Revision number’ on the LED device.

8. If the ‘Verify’ process shows ‘Checksum Error’, it means the target module has different program than in the PROGRAM module. Select ‘Download mode’ to start downloading process.

9. If ‘Download Error – verify cksum err’ status shows on the LED device, the download process is not successful. Repeat Step 6

through 9 till 'Download Completed – Verify OK! Rev. #' message is displayed.

10. Unplug the connector from the target module.

11. Disconnect program-related connectors.

12. Program download is now complete. Reconnect connectors to original configuration as required.

Factory Troubleshooting and Repair

Note: DINEX module internal components are not field-repairable

- If Levels 1 through 3 troubleshooting and diagnostics fail to show the cause for failures or poor performances, the suspect module must be returned to the manufacturer for more rigorous troubleshooting and repair.

7

- I/O Failure
- Module Failure
- System Failure

Failure Analysis and Corrective Action

I/O Failure

This operation is to be used where a limited number of input or output points have malfunctioned within each module.

Visual Check -- Output Mode

- Check the fuse.
- Check feedback amber* and red LEDs. Amber* LED checks the circuit integrity. If the circuit is open for any reason during non-active/ red LED off mode, the amber* LED will be off. If the circuit is functioning the amber* LED will be on.
- The red LED confirms that the output is activated by the computer. If both the red and amber* LEDs are on, check the fuse.

Use Of Tools

- Use the T-MK-808 to confirm the test.

Corrective Action

NOTE: *Some applications use green LED instead amber LED, according to the specifications of various bus manufacturers.*

- Check to see if a fuse is burned out.
- Check for possible short circuit.
- If amber* LED is off, check for open circuit.
- If both red and amber* LEDs are off, replace module and check circuit.

Module Failure

When a full bank of functions is not working, a module failure has occurred or the output section is missing the power connection.

Visual Check

- Check the communications.
- Check LEDs. If an LED is off, and remains off, module-networking capability is malfunctioning.
- Check powers supply yellow LED. Is every yellow LED on? If the yellow LED is on, system power is fine.

Use of Tools

- T-MK-808 is used to check ID and IO.

Corrective Action

- Check DATA BUS wires integrity. Reset the module by disconnecting the data bus. Replace module.

System Failure

This level of failure is indicated when the system operates as follows:

- Abnormally.
- System is dead.
- Control of the system is lost.

Before proceeding

- Reset the system.
- Shut down/ reset the battery.

Visual Check

- Check every network module LED. All modules should be blinking rapidly.
- If LEDs are not blinking rapidly, check the MBC data bus connection.
- If LED's are blinking, run the BIST and check for DINEX module communication failure indication.

Use of Tools

- Use G2A-MK-808 ID checking mode for data bus integrity.

Corrective Action

- After resetting the system, if the condition persists. Replace the MBC module

- **G2A-MBC-32: Main Bus Controller with Power Management System Module**
- **G2A-DIO-888: Intelligent Digital Input/Output Module**
- **T2-DIO-24OG-R7: Intelligent Digital 24 Output Gateway Module**
- **T2-DIO-32LED-OB-01: 32LED indicator Panel**

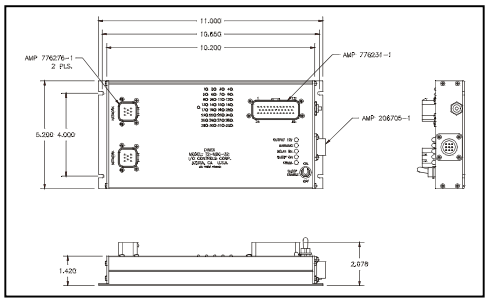
8

Technical Specification

G2A-MBC-32
Main Bus Controller with Power Management System Module

MODULE FEATURES

- Controller.
- Stores instructions for control and monitor.
- Programmable logic for sequence of operations.
- Software compiler available.
- Controls and monitors up to 16 sub-nodes.
- Interface for 32 Inputs.
- Four groups of 16-8-4-4 input points may be source reference or ground reference inputs.
- Built-in timer interrupts function.
- Supports multiple, hierarchical network levels.
- Supports connections to other computers and Automatic Test Equipment.
- For control and monitoring of devices.
- All I/O points are optically isolated.
- LED status indicators provided on all I/O points.
- Replaces relays with solid state, electrical switching.
- Polarity of I/O signals is set by hard wiring, the next assembly wiring harness as appropriate.
- Communication with 115K Baud Dinex G2 Modules



STANDARD DINEX FEATURES

Network

- Integrates with intelligent network control system.
- Allows system expansion.
- Easy to use and program.
- Interfaces to Personal Computers and other host computers.

Construction

- Small, compact, light weight and rugged.
- Simple to field replace.
- Built-in high speed RISC microprocessor with EEPROM.
- Designed with CMOS circuitry for low power consumption.
- Designed with CMOS and FET circuitry for low power consumption.

Multiplex Communication

- Fault tolerant RS485 data communication bus.
- 115 Kbps data communication rate.

- LED status indicator during communication operation.
- Dual communication ports for ring-loop hook-up capability.

APPLICATIONS

- Main Bus Controller for Multiplexing Systems.
- Master Bus Controller replacing computers.
- Controller for on-board Self-Tests and/or connections to external Automatic Test Equipment for diagnostics.
- Interfaces to switches, such as limit switches, temperature and pressure switches, pushbutton and selector switches.

PRODUCT DESCRIPTION

The Main Bus Controller (G2A-MBC-32) is a network controller with power driver, which provides the complete functions acting as a full-size computer. The module can be established as a Bus Controller which controls multiple nodes or which can directly control other node modules. The MBC module can provide a direct interface for the operator interface, including switches, LED indicators and digital displays.

OPTIONS

Module

- Alternate connector types and configurations, or color coded wire pigtails.
- Resistance for exposure to the ambient environment, without a required enclosure.
- Optional RS-232 Port by special order.

Support Equipment

- DINEX T2-MK-232 Converter Box for RS232 serial port (PC compatible) to DINEX data communication bus.
- Handheld Field Programmer.
- Simulator.

TECHNICAL SPECIFICATIONS

General

- Operating temperature range: -40°C to +85°C
- Humidity: 10% to 100%, saturated
- Shock: up to 20 g
- Vibration: 5 to 35 Hz, 2mm double amplitude, 2 hours

MODULE

Inputs **System Module**

- Input voltage: 16-32 VDC
- Reverse voltage protection: 32 VDC
- Input current at rated pick-up voltage: 5mA
- Input current at maximum voltage: 15mA
- Turn on/off time: 15 millisecond maximum

LED Indicators

- green indicators for inputs.

Module and Programming

- High speed microprocessors.
- 8000 programming lines of stack code.
- Integrated word look-up table.
- 16K byte of EEPROM.
- network data exchange registers
- Fast program cycle time 3 microseconds.
- I/O excursion time 1575 microseconds.
- Extended compiler instruction set.
- Swap and rotate capability.
- Programming direct jump capability.
- Extended instruction set built into firmware.
- Direct control of other sub-level Cell Net Controllers.
- Built-in error detection, check sum protocol for faster operation.
- Uses standard ASCII text editor to generate source code, such as Microsoft DOS Edit.
- Uses Dinex Ladder Logic GUI language to generate source code, object code, system documentation.

Network Linking Capability

- One uplink to higher level controller.
- 16 downlinks to lower level controller and/or other DINEX modules.
- Note: The 32 input section uses one downlink address. Those 32 inputs may be made available to a redundant MBC controller.

PROGRAMMING SUPPORT SOFTWARE

- DINEX Ladder Logic GUI language
- DINEX G2 Utility Program.
- High Speed Compiler (PC compatible).
- IOL2.3 Downloader (PC compatible).
- Debugger/Single Step Execution.

SUPPORT DOCUMENTATION

- DINEX G2 Utility Program User Reference Manual.

PIN ASSIGNMENT

AMP 207121-1	
1-32	INPUT 1-32
33	COM1 FOR INPUT 1-16
34	COM2 FOR INPUT 17-24
35	COM3 FOR INPUT 25-28
36	COM4 FOR INPUT 29-32

AMP 207441-1	
1	DNET-A
2	DNET-B
3	+VIN
4	GROUND
5	CNET-A
6	CNET-B
7	PROG_L
8	RESET_L

AMP 206705-1	
1	12V (+)
2	12V (-)
3	RESERVE
4	WARNING OUTPUT
5	MASTER SW POS. 6
6	A 485
7	B 485
8	GROUND
9	BATTERY 24V

G2A-DIO-888
Intelligent Digital Input/Output Module

MODULE FEATURES

- 8 input points.
- 8 output points, high power DC version.
- 8 internal feedback monitoring LEDs, for determining the status of control devices and loads.
- 8 internal feedback current less than 100 uA.
- Each Output point is fuse protected, and includes an easily accessible, sealed fuse holder.
- All I/O points are optically isolated.
- Outputs may be any combination of source and sink outputs.
- LED status indicators provided on all I/O points.
- Polarity of input/output signals is set by hard wiring the next assembly wiring harness as appropriate.
- Replaces relays with solid state, electrical switching.
- Communication with 115K Baud Dinex G2A modules

STANDARD DINEX FEATURES

Network

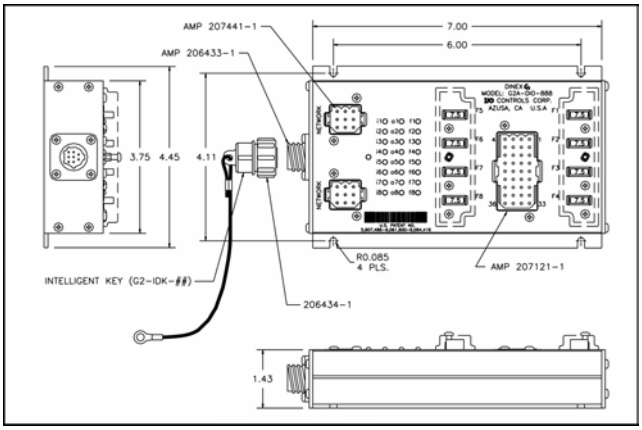
- Integrates with intelligent network control system.
- Allows system expansion.
- Easy to use and program.
- Interfaces to Personal Computers and other host computers.

Construction

- Small, compact, lightweight and rugged.
- Simple to field replaces.
- Built-in high speed RISC microprocessor with EEPROM.
- Designed with CMOS circuitry for low power consumption.
- Designed with CMOS and FET circuitry for low power consumption.

Multiplex Communication

- Fault tolerant RS485 data communication bus.
- 115 Kbps data communication rate.
- LED status indicator during communication operation.
- Dual communication ports for ring-loop hook-up capability.



APPLICATIONS

- Used for turning on and off electrical power to control devices and loads, such as solenoid valves, lights, electrical clutches, heaters and motor starters.
- Can apply electrical power to fareboxes, radios and other electrical subsystems.
- Interfaces to switches, such as limit switches, temperature and pressure switches, pushbutton and selector switches.

PRODUCT DESCRIPTION

The G2A-DIO-888 module is a digital input and output module for on/off state devices. The module includes both inputs for monitoring switches and outputs for control devices in a very compact package. Internal feedback monitoring provides the ability to determine if a load is active, in addition to the wiring and output fuse.

Each I/O point is optically isolated and fused for protection against voltage spikes, transients and short circuits. The optical isolation also provides electrical noise immunity.

Each module has a unique programmable field address and each I/O point can be separately monitored and controlled by a Cell Net Controller or computer.

There are 8 inputs can be wired as ground-switched inputs or voltage-switched inputs. Polarity of input signals is set by hard wiring the next assembly wiring harness as appropriate.

The output section has two connections for circuit power and ground for purposes of applying power to control the output switching transistors. Each output may be a source output or a sink output. Polarity of

output signals is set by hard wiring the next assembly wiring harness as appropriate

OPTIONS

Module

- Alternate connector types and configurations, or color coded wire pigtails.
- Resistance for exposure to the ambient environment, without a required enclosure.

Support Equipment

- DINEX T2-MK-232 Converter Box for RS-232 serial port (PC compatible) to DINEX data communication bus.
- Handheld Field Programmer.
- Simulator.

TECHNICAL SPECIFICATIONS

General

- Operating temperature range: -40°C to +85°C
- Humidity: 10% to 100%, saturated
- Shock: up to 20 g
- Vibration: 5 to 35 Hz, 2mm double amplitude, 2 hours

MODULE

Inputs

- Input voltage: 8-32 VDC
- Reverse voltage protection: 32 VDC
- Input current at rated pick-up voltage: 5mA
- Input current at maximum voltage: 15mA
- Turn on/off time: 15 millisecond maximum

Outputs

- Load voltage: 8-32 VDC
- Continuous load output current: 7.5 Amp
- High power output option for ch1 to ch4: 15 Amp continuous load
- Leakage current at nominal load voltage: 100 uA max.
- Turn on/off time: 15 millisecond maximum
- Total output current is 40 Amp Maximum

LED Indicators

- 8 green indicators for inputs.
- 8 red indicators for outputs.
- 8 amber indicators for internal feedback monitoring of load.

PIN ASSIGNMENT

AMP 207121-1

PIN	*POWER OUTPUT CONNECTION*	**SINK OUTPUT CONNECTION**
1,2	CH 1 POWER	CH 1 OUTPUT
5,6	CH 1 OUTPUT	GROUND
9,10	CH 2 POWER	CH 2 OUTPUT
13,14	CH 2 OUTPUT	GROUND
17,18	CH 3 POWER	CH 3 OUTPUT
21,22	CH 3 OUTPUT	GROUND
25,26	CH 4 POWER	CH 4 OUTPUT
29,30	CH 4 OUTPUT	GROUND
4	CH5 POWER	CH 5 OUTPUT
8	CH 5 OUTPUT	GROUND
12	CH6 POWER	CH 6 OUTPUT
16	CH 6 OUTPUT	GROUND
20	CH 7 POWER	CH 7 OUTPUT
24	CH 7 OUTPUT	GROUND
28	CH 8 POWER	CH 8 OUTPUT
32	CH 8 OUTPUT	GROUND
33	GROUND	GROUND
34	POWER 24V/12V	POWER 24V/12V
3	INPUT 1	INPUT 1
7	INPUT 2	INPUT 2
11	INPUT 3	INPUT 3
15	INPUT 4	INPUT 4
19	INPUT 5	INPUT 5
23	INPUT 6	INPUT 6
27	INPUT 7	INPUT 7
31	INPUT 8	INPUT 8
35	INPUT COMMON	INPUT COMMON
36	N/C	N/C

AMP 207441-1	
1	DNET-A
2	DNET-B
3	+VIN
4	GROUND
5	LOOP 5
6	LOOP 6
7	LOOP 7
8	LOOP 8
9	N/A

T2-DIO-24OG-R7
Intelligent Digital 24 Output Gateway Module

MODULE FEATURES

- For driving the LED module.
- 24 transistor 20 mA sink output points.
- Acts as gateway on DINEX network and other host system.
- Isolation output.

STANDARD DINEX FEATURES

Network
- Integrates with intelligent network control system.
- Allows system expansion.
- Easy to use and program.
- Interfaces to Personal Computers and other host computers.

Construction
- Small, compact, lightweight and rugged.
- Simple to field replaces.
- Potted for environmental protection.
- Built-in high speed RISC microprocessor with EEPROM.
- Designed with CMOS circuitry for low power consumption.
- 2 data communication connectors for in/out.

Multiplex Communication
- Fault tolerant RS-485 data communication bus.
- 115K bps data communication rate.
- LED status indicator during communication operation.

APPLICATIONS

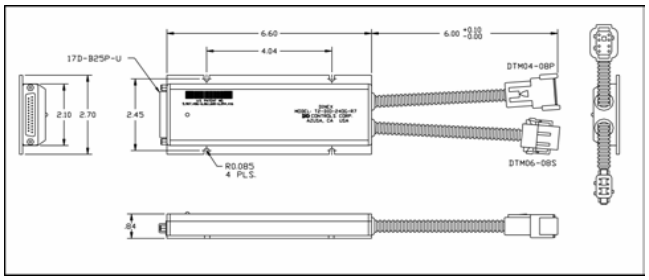
- Interfaces with panel LED display module or with load less than 20mA output.

PRODUCT DESCRIPTION

The T-DIO-24OG-R2 is a digital gateway module for on/off state signals. The module is designed for grounding the output in open collector format. Each module has a unique programmable field address and each I/O point can be separately monitored and controlled by a Cell Net Controller or computer.

OPTIONS

Module
- Alternate connector types and configurations, or color coded pigtails.



TECHNICAL SPECIFICATIONS

General
- Operating temperature range: - 0°C to +65°C
- Optional extended temperature: - 35°C to +85°C
- Humidity: 10% to 100%, non-saturated
- Shock: up to 20 g
- Vibration: 5 to 35 Hz, 2mm double amplitude, 2 hours

INTERFACE INFORMATION

Computer input power: 9 VDC +3/-2V at 200mA Maximum, isolated supply.
Data communication bus and power connector:
IOC MPX side: DEUTSCH DTM04-08PA 8-pin

Connector

Pin # 1 =RS-485 A
Pin # 2 =RS-485 B
Pin # 3 =V+
Pin # 4 =GND
Pin # 5 =direct circuit bypass
Pin # 6 =direct circuit bypass
HOST side: AMPHENOL 17D-B25P DB-25 male connector or equivalent.
Pin #1 to PIN # 24 = BIT #1 to BIT # 24
Pin #25 = GND

SUPPORT DOCUMENTATION

DINEX Utility Program User Reference Manual.

T2-LED32-OB-01
32LED Indicator Panel

MODULE FEATURES

- For monitoring of devices.
- 32 low level LED output.
- Each point assigned as an output point.
- Non-isolated IO.
- Acts as node in DINEX network.

STANDARD DINEX FEATURES

Network
- Integrates with intelligent network control system.
- Allows system expansion.
- Easy to use and program.
- Interfaces to Personal Computers and other host computers.

Construction
- Small, compact, lightweight and rugged.
- Simple to field replaces.
- Potted for environmental protection.
- Designed with CMOS and FET circuitry for low power consumption.

Multiplex Communication
- Fault tolerant RS-485 data communication bus.
- 115K bps data communication rate.
- LED status indicator during communication operation.

APPLICATIONS

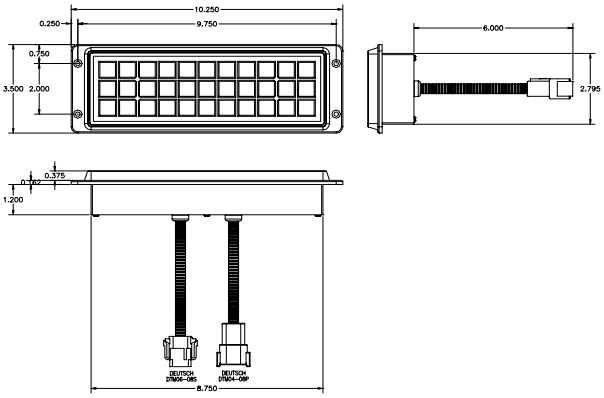
- As instrument panel warning light cluster.
- Customized LED arrangement.

PRODUCT DESCRIPTION

The T2-32LED-OB-01 module is a digital LED output unit for on/off state signals. The module includes 32 high brightness LED blocks for warning indicator or status indicator.
Each module has a unique programmable field address and each I/O point can be separately monitored and controlled by a Cell Net Controller or computer.

OPTIONS

Module
- Alternate connector types and configurations, or color coded pigtails.
- Discrete input connections for special items. Such as stop engine signal, check engine signal, directly connected to engine controls. Such a fire signal or ABS signal, directly connected to other control system.



TECHNICAL SPECIFICATIONS

General
- Operating temperature range: - 40°C to +85°C
- Humidity: 10% to 100%, non-saturated
- Shock: up to 20 g
- Vibration: 5 to 35 Hz, 2mm double amplitude, 2 hours

Outputs
Non-isolated LED blocks.

9

Appendix

ID Keys for G2A System

General Description

In Dinex G2A system, each module has been signed a unique 'ID' number to identify himself. The unique address symbol (two digits of numerical number) which is assigned to each ID key. Each ID key should be connected with each functional unit (module) in the network. Each ID Key's number can not be changed (no re-writable). Some special module has built in ID function such as MBC, T2-DIO-24OG-R7, and RT2-32LED-OB-01; the ID number can be changed.

Typical Information

Module's Name	Zone Location	ID # XX
A1 (MBC)	Zone A	ID # = 77 (built in & re-writable)
A2	Zone A	ID # = 64
A3	Zone A	ID # = 65
A4	Zone A	ID # = 66
B1	Zone B	ID # = 78 (built in & re-writable)
C1	Zone C	ID # = 67
C2	Zone C	ID # = 68
D1	Zone D	ID # = 69
D2	Zone D	ID # = 70
D3	Zone D	ID # = 71

FIGURE: 9.1 – ID KEY'S TABLE

NOTE: *On some models, according to specification of each particular customer, the module's ID number may be assigned differently.*

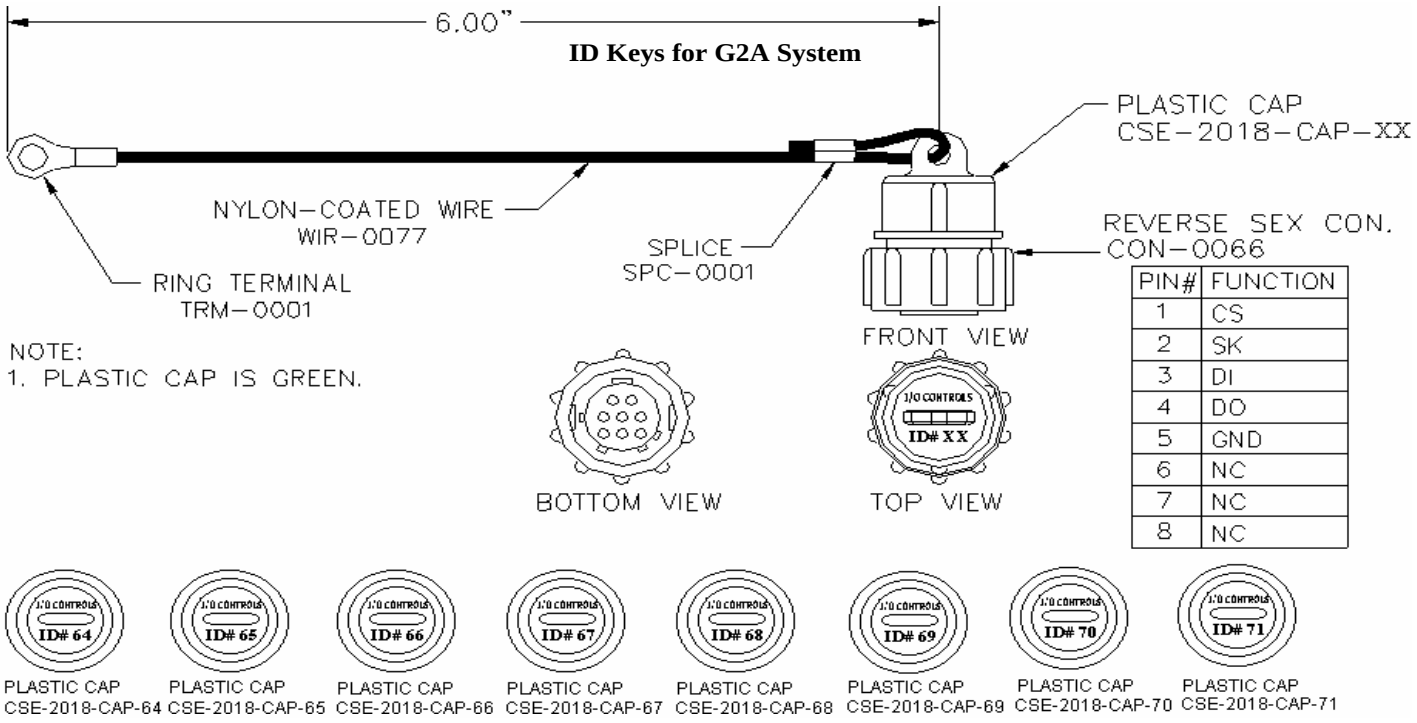


FIGURE: 9.2 – ID KEY'S DIAGRAM

Designer: Paul Boulet Project Name: M450LXI REV A

Customer:

OEM Serial: 11

Designed By: Paul Boulet

Last Modified On: 6/10/2005

Program Revision: A

Software Version:

Build Date:

Contents

Map

Designer: Paul Boulet Project Name: M450LXI REV A

A1

ID 77 **Type:** DIO 32/0

Description MBC 32IN MODULE

Input

Name	Wire #	Color	Voltage	Description
A1-I01	MBC001	TN	GND	KEY SW IGNITION
A1-I02	MBC002	RD	GND	HEADLIGHT SW ON POSITION
A1-I03	MBC003	OR	GND	HEADLIGHTS PARK POSITION
A1-I04	MBC004	YL	GND	KEY SWITCH - START POSITION
A1-I05	MBC005SP1	GN	GND	SPARE
A1-I06	MBC006SP2	BL	GND	SPARE
A1-I07	MBC007	PU	GND	SPARE
A1-I08	MBC008	GY	GND	N/A
A1-I09	MBC009	BK	GND	N/A
A1-I10	MBCO10	PK	GND	HAZARD SW
A1-I11	MBC011	TN	GND	N/A
A1-I12	MBC012	RD	GND	N/A
A1-I13	MBC013	OR	GND	N/A
A1-I14				N/A
A1-I15	MBC015	GN	GND	CLEARANCE LTS SW
A1-I16	MBC016	BL	GND	N/A
A1-I17	MBC017	PU	GND	N/A
A1-I18				N/A
A1-I19	MBC019	BK	GND	N/A
A1-I20	MBC020	PK	GND	N/A
A1-I21	MBC021	TN	GND	N/A
A1-I22	MBCO22	RD	GND	SMRT WHL HORN REQ
A1-I23	MBC023	OR	GND	HORN SW
A1-I24	MBC024	YL	GND	ACCESSORY (RV)
A1-I25	MBC025	GN	24V	SPARE
A1-I28		GY		12V DISCONNECT SHUTDOWN
A1-I30				N/A
A1-I31	MBC231	TN	24V	NEUTRAL SIGNAL
A1-I32				N/A

Flag

Name	Location	Description
A1-F01	A1-D01, R 0	ATS OK TO RUN FLAG
A1-F02	A1-D01, R 1	BIST COMBO FLAG
A1-F03	A1-D01, R 8	SLOW BIST FLAG
A1-F04	A1-D01, R 10	BIST CHIRP FLAG
A1-F05	A1-D01, R 12	FLASH CODE FLAG
A1-F06	A1-D02, R 2	CAT NO DATA J1939 FROM ENGINE

Designer: Paul Boulet Project Name: M450LXI REV A

A1-F07	A1-D02, R 4	ABS NO DATA J1939

Code

Name	Description
A1-C01	DINEX G2 KERNEL 1 CALL SUBROUTINES
A1-C02	DINEX G2 KERNEL 2 MAIN BODY SUBROUTINES
A1-C03	DINEX G2 KERNEL 3 FLASH CODE FLAG
A1-C04	DINEX G2 KERNEL 4 RESET BIST
A1-C05	DINEX G2 KERNEL BIST COUNTER
A1-C06	DINEX G2 KERNEL 6 SLOW BIST FLAG
A1-C07	DINEX G2 KERNEL 7 FORCE POINTS
A1-C08	START-UP SEQUENCE J1939
A1-C09	CATERPILLAR J1939 TO DINEX
A1-C10	ABS J1939 TO DINEX
A1-C11	J1939 DINEX J1939 OUTPUTS

Designer: Paul Boulet Project Name: M450LXI REV A

A2

ID 64 **Type:** DIO 8/8

Description ZONE A2 DIO 808

Input

Name	Wire #	Color	Voltage	Description
A2-I01	A2-003	OR	GND	HORN SELECT SW (ELECTRIC)
A2-I02	A2-007	PU	GND	HORN SELECT (AIR) SW
A2-I03	A2-011	YL	GND	CRUISE CONTROL CANCEL (FROM SMART WHEEL)
A2-I04	A2-015	GN	GND	ABS TRACT CTRL SW
A2-I05	A2-019	BK	GND	MIRROR HEAT SW
A2-I06	A2-023	OR	GND	N/A
A2-I07	A2-027	PU	GND	N/A
A2-I08				HEADLAMP FLASH (SIGNAL FROM SMART WHEEL)

Output

Name	Wire #	Color	Voltage	Location	Description
A2-O01	A2-105	GN	12V	A2D01, R 0	NEUTRAL
A2-O02	A2-113	OR	12V	A2D01, R 2	REVERSE
A2-O03	A2-121	TN	12V	A2D01, R 4	LH DIR LIGHT
A2-O04				A2D01, R 6	SMART WHL IGN
A2-O05	A2-108	GY	12V	A2D01, R 9	MIRROR HEAT
A2-O06	A2-116	BL	12V	A2D01, R 11	RH DIR LIGHT
A2-O07	A2-124	YL	12V	A2D01, R 14	AIR HORN
A2-O08				A2D02, R 0	DIMMER

Timer

Name	Timer Type	Time	Time Off	Description
A2-T03	Delay Off	300.00		5 MINUTE TIMER

Designer: Paul Boulet Project Name: M450LXI REV A

A3

ID 65 **Type:** DIO 8/8

Description ZONE A3 DIO 808

Input

Name	Wire #	Color	Voltage	Description
A3-I01	A3-003	OR	GND	CRUISE ON/OFF SW
A3-I02	A3-007	PU	GND	CRUISE SET SW
A3-I03	A3-011	TN	GND	CRUISE RESUME SW
A3-I04	A3-015	GN	GND	ENGINE BRAKE ENABLE SW
A3-I05	A3-019	BK	GND	ENGINE BRAKE LOW SW
A3-I06	A3-023	OR	GND	ENGINE BRAKE MED SW
A3-I07	A3-027	PU	GND	ENG BRAKE HI
A3-I08	A3-031	TN	GND	HIGH IDLE SW

Output

Name	Wire #	Color	Voltage	Location	Description
A3-O01	A3-205/206		24V	A3D01, R 0	12V/24V IGN BUS
A3-O02				A3D01, R 2	3 MPH SIGNAL (RV)
A3-O03	A3-121	PK	12V	A3D01, R 4	IGNITION, WEBASTO
A3-O04	A3-129	BK	12V	A3D01, R 7	PARK BRAKE (RV)
A3-O05	A3-108	GY	12V	A3D01, R 10	3 MPH SIG (AIR LEVEL)
A3-O06	A3-012	RD	GND	A3D01, R 14	PARK AND ACCESSORY (FOR SLIDEOUT)
A3-O07	A3-124	YL	12V	A3D02, R 0	HI BEAM LIGHT
A3-O08	A3-232	RD	24V	A3D02, R 2	ELECTRIC HORN

Designer: Paul Boulet Project Name: M450LXI REV A

A4

ID 66 **Type:** DIO 8/8

Description ZONE A4 DIO 808

Input

Name	Wire #	Color	Voltage	Description
A4-I01				N/A
A4-I02	A4-007	PU	GND	SHIFT INH (RV)
A4-I03	A4-011	TN	GND	N/A
A4-I04	A4-105	GN	GND	MASTER RLY INPUT (RV)
A4-I05				N/A
A4-I06				N/A

Output

Name	Wire #	Color	Voltage	Location	Description
A4-O01	A4-001	TN	GND	A4D02, R 0	PARK BRAKE (FOR DRL MODULE)
A4-O02				A4D02, R 2	GPS PARK LIGHTS
A4-O03				A4D02, R 5	PARK BRAKE (TT)
A4-O04	A4-025	GN	GND	A4D02, R 7	ENGINE BRAKE
A4-O05	A4-108	GY	12V	A4D02, R 9	HEADLIGHT ALERT
A4-O06	A4-012	RD	GND	A4D03, R 0	ABS TELLTALE
A4-O07	A4-020	PK	GND	A4D03, R 2	ATC TELLTALE
A4-O08	A4-132	RD	12V	A4D03, R 4	HEAT SENSOR TELLTALE

Timer

Name	Timer Type	Time	Time Off	Description
A4-T01	Turn On	2.00		TURN ON 2 SEC

Flag

Name	Location	Description
A4-F01		RAMP FLAG
A4-F02		KNEEL DOWN FLAG
A4-F03		KNEEL UP FLAG

Designer: Paul Boulet Project Name: M450LXI REV A

B1

ID 72 **Type:** DIO 8/8

Description B1 MODULE

Input

Name	Wire #	Color	Voltage	Description
B1-I01	B1-003	OR	GND	HIGH BEAM SW
B1-I02	B1-007	PU	GND	LFT TURN SW
B1-I03	B1-011	TN	GND	RT TURN SW
B1-I07	B1-027	PU	GND	SERVICE BRK PSI SW
B1-I08	B1-031	TN	GND	P BRAKE PSI SW

Output

Name	Wire #	Color	Voltage	Location	Description
B1-O01				B1-D01, R 2	LOW BEAM LTS
B1-O02				B1-D01, R 5	HIGH BEAM LTS
B1-O03				B1-D01, R 7	LFT TURN LTS & MIRROR
B1-O04				B1-D01, R 11	RT TURN LTS & MIRROR
B1-O05				B1-D02, R 0	ON STAR BATTERY
B1-O06	B1-116	BL	12V	B1-D02, R 2	HDLMP SIG TO S WHL
B1-O07	B1-124	YL	12V	B1-D02, R 4	ON STAR IGNITION
B1-O08				B1-D02, R 6	CAT MES IGN

Timer

Name	Timer Type	Time	Time Off	Description
B1-T01	Flash	0.50	0.50	FLASH TIMER

Flag

Name	Location	Description
B1-F01	B1-D01, R 0	FLASH FLAG

Designer: Paul Boulet Project Name: M450LXI REV A

B2

ID 73 **Type:** DIO 8/8

Description B2 MODULE

Input

Name	Wire #	Color	Voltage	Description
B2-I05	B2-019	BK	GND	FOG LT SW
B2-I06				DASH FRT DOOR LOCK SW

Output

Name	Wire #	Color	Voltage	Location	Description
B2-O01				B2-D01, R 0	FOG LTS
B2-O02				B2-D01, R 2	FRONT MARKERS
B2-O03				B2-D01, R 5	LEVEL SEN IGN
B2-O04				B2-D01, R 7	MARKER LIGHTS
B2-O06	B2-116	BL	12V	B2-D02, R 2	ADJ PEDAL CMD OUT
B2-O07				B2-D02, R 4	PARK BRK HADLEY
B2-O08					GEN RUN FRONT A/C

Designer: Paul Boulet Project Name: M450LXI REV A

D1

ID 69 **Type:** DIO 8/8

Description ZONE D1 DIO 808

Input

Name	Wire #	Color	Voltage	Description
D1-I01	D1-003	OR	GND	TEMP DETECTORS
D1-I02	D1-007	PU	GND	GEN RUN SIGNAL ALT 1
D1-I03	D1-011	TN	GND	GEN RUN SIG ALT 2
D1-I04	D1-015	GN	GND	HOT HYD FLUID FAN

Output

Name	Wire #	Color	Voltage	Location	Description
D1-O01	D1-105/106		12V	D1D01, R 0	TAIL LIGHTS
D1-O02	D1-113/114		12V	D1D01, R 3	STOP LAMPS
D1-O03	D1-121/122		12V	D1D01, R 5	R/S TURN SIGNAL
D1-O04	D1-129/130		12V	D1D01, R 7	C/S TURN SIGNAL
D1-O05				D1D01, R 11	AIR DRYER
D1-O06	D1-116	BL	12V		HAND THROT ENABLE
D1-O07	D1-124	YL	12V	D1D02, R 3	BACKUP ALARM/LIGHTS
D1-O08	D1-132	RD	12V		DECEL LIGHTS

Designer: Paul Boulet Project Name: M450LXI REV A

D2

ID 70 **Type:** DIO 8/8

Description ZONE D2 DIO 808

Input

Name	Wire #	Color	Voltage	Description
D2-I01	D2-003	OR	GND	IGN CNTL-FWD SW
D2-I02	D2-007	PU	GND	IGN CNTL-REAR SW
D2-I03	D2-011	TN	GND	REAR START SW
D2-I04	D2-015	GN	GND	ENGINE DOOR OPEN
D2-I05	D2-019	BK	GND	N/A
D2-I06	D2-023	OR	GND	WATER IN FUEL
D2-I07				CHECK ENGINE TT
D2-I08				STOP ENGINE TT

Output

Name	Wire #	Color	Voltage	Location	Description
D2-O01	D2-205	GN	24V	D2D01, R 0	FUEL HEATER
D2-O02					REAR LANDING LTS
D2-O03	D2-222	RD	24V	D2D01, R 6	STARTER SOLENOID
D2-O04	D2-229/230		24V		WATER PUMP
D2-O05	D2-208	GY	24V	D2D01, R 14	HYDRAULIC FAN RLY
D2-O06	D2-216	BL	24V		AIR DRYER
D2-O07	D2-224	YL	24V	D2D02, R 3	REAR IGN POWER
D2-O08	D2-232	RD	24V	D2D02, R 8	ALTERNATOR EXCITER/FAN POWER

Timer

Name	Timer Type	Time	Time Off	Description
D2-T01	Turn On	15.00		15 SEC TIMER
D2-T02	Delay Off	1.00		ALT EXCITER 1 SEC

Designer: Paul Boulet Project Name: M450LXI REV A

D3

ID 71 **Type:** DIO 8/8

Description ZONE D3 DIO 808

Input

Name	Wire #	Color	Voltage	Description
D3-I01	D3-003	OR	GND	THREE MPH SPEED SIGNAL (167V5)
D3-I06	D3-023	OR	GND	CHECK TRANS SIGNAL (115S31)
D3-I07	D3-027	PU	GND	REVERSE SIGNAL (113V4)
D3-I08	D3-031	BN	GND	HOT RANS SIGNAL (105V19)

Output

Name	Wire #	Color	Voltage	Location	Description
D3-O01	D3-001	TN	GND	D3D01, R 1	THROTTLE INTERLOCK
D3-O02				D3D01, R 4	ENG SERV BRAKE
D3-O03	D3-018	GY	GND	D3D01, R 6	ENG BRK LO/HI
D3-O04				D3D01, R 8	ENG BRAKE MED/HI
D3-O05	D3-004	YL	GND	D3D02, R 0	FAST IDLE
D3-O06	D3-012	RD	GND	D3D02, R 4	TRANS SERV BRK
D3-O07	D3-020	PK	GND	D3D02, R 8	SHIFT ENABLE
D3-O08	D3-028	GY	GND	D3D02, R 13	ABS TRACT CNTRL

Designer: Paul Boulet Project Name: M450LXI REV A

GI

ID 80 **Type:** DIO 0/32

Description GW-J1939 INPUT RUNGS

Flag

Name	Location	Description
GI-F01	GI-D01, R 0	LOW COOLANT
GI-F02	GI-D01, R 2	IDLE VALIDATION ACCEL PEDAL POSITION
GI-F03	GI-D01, R 4	STOP ENGINE
GI-F04	GI-D01, R 6	CHECK ENGINE
GI-F05	GI-D01, R 8	ABS WARN LAMP AMBER
GI-F06	GI-D01, R 10	ATC LAMP STATE

Code

Name	Description
GI-C01	J1939 FROM CAT COOLANT LEVEL
GI-C02	J1939 FROM CAT ACCEL PEDAL POSITION
GI-C03	J1939 FROM CAT BIT 1
GI-C04	J1939 FROM CAT BIT 2
GI-C05	J1939 FROM ABS BIT 1
GI-C06	J1939 FROM ABS BIT 2

Designer: Paul Boulet Project Name: M450LXI REV A

GO

ID 79 **Type:** DIO 0/32

Description GW-J1939 OUTPUT RUNGS

Flag

Name	Location	Description
GO-F32	GO-D01, R 11	GW-J1939 COMM FAIL FLAG

Code

Name	Description
GO-C01	J1939 ENABLE CRUISE SW
GO-C02	J1939 SET CRUISE SW
GO-C03	J1939 RESUME CRUISE SW
GO-C04	J1939 COAST CRUISE SW
GO-C05	J1939 ACCEL CRUISE SW
GO-C32	J1939 OUTPUTS FROM DINEX

Designer: Paul Boulet Project Name: M450LXI REV A

System

ID 0 **Type:** System

Description System Flags

Flag

Name	Location	Description
FOK	S1-D01, R 0	Force Output OK
FSCAN		System 1st Scan

Designer: Paul Boulet Project Name: M450LXI REV A

Cross Reference for **A1** **Type:** DIO 32/0

Name	Diagram	Location
A1-I01	A1-D01	Row 0, Col 0
A1-I01	A1-D01	Row 2, Col 2
A1-I01	A2-D01	Row 6, Col 0
A1-I01	A2-D01	Row 9, Col 0
A1-I01	A3-D01	Row 0, Col 0
A1-I01	A3-D01	Row 10, Col 0
A1-I01	A3-D01	Row 4, Col 0
A1-I01	A4-D02	Row 9, Col 0
A1-I01	A4-D03	Row 0, Col 1
A1-I01	A4-D03	Row 2, Col 1
A1-I01	B1-D01	Row 11, Col 0
A1-I01	B1-D01	Row 7, Col 0
A1-I01	B1-D02	Row 0, Col 0
A1-I01	B1-D02	Row 4, Col 0
A1-I01	B1-D02	Row 6, Col 0
A1-I01	B2-D01	Row 0, Col 0
A1-I01	B2-D01	Row 5, Col 0
A1-I01	B2-D02	Row 2, Col 0
A1-I01	B2-D02	Row 3, Col 1
A1-I01	D1-D01	Row 11, Col 0
A1-I01	D1-D01	Row 5, Col 0
A1-I01	D1-D01	Row 7, Col 0
A1-I01	D1-D02	Row 3, Col 0
A1-I01	D2-D01	Row 0, Col 0
A1-I01	D2-D01	Row 14, Col 0
A1-I01	D2-D01	Row 6, Col 0
A1-I01	D2-D01	Row 8, Col 0
A1-I01	D2-D02	Row 3, Col 0
A1-I01	D2-D02	Row 8, Col 0
A1-I01	D3-D01	Row 4, Col 0
A1-I01	D3-D01	Row 6, Col 0
A1-I01	D3-D01	Row 8, Col 0
A1-I01	D3-D02	Row 0, Col 0
A1-I01	D3-D02	Row 13, Col 0
A1-I01	D3-D02	Row 4, Col 0
A1-I01	D3-D02	Row 8, Col 0
A1-I01	S1-D01	Row 0, Col 0
A1-I02	A2-D02	Row 0, Col 0
A1-I02	A4-D02	Row 2, Col 1
A1-I02	A4-D02	Row 9, Col 1
A1-I02	B1-D01	Row 2, Col 1
A1-I02	B1-D01	Row 3, Col 2
A1-I02	B1-D01	Row 5, Col 1
A1-I02	B1-D02	Row 2, Col 1
A1-I02	B2-D01	Row 0, Col 1
A1-I02	B2-D01	Row 2, Col 1
A1-I02	B2-D01	Row 7, Col 0
A1-I02	D1-D01	Row 0, Col 0
A1-I03	A2-D02	Row 1, Col 0
A1-I03	A4-D02	Row 10, Col 1
A1-I03	A4-D02	Row 3, Col 1
A1-I03	B2-D01	Row 3, Col 1

Designer: Paul Boulet Project Name: M450LXI REV A

A1-I03	B2-D01	Row 8, Col 0
A1-I03	D1-D01	Row 1, Col 0
A1-I04	D2-D01	Row 6, Col 1
A1-I04	D2-D01	Row 8, Col 1
A1-I10	B1-D01	Row 13, Col 0
A1-I10	B1-D01	Row 9, Col 0
A1-I10	D1-D01	Row 6, Col 0
A1-I10	D1-D01	Row 9, Col 0
A1-I22	A2-D01	Row 14, Col 1
A1-I22	A3-D02	Row 2, Col 1
A1-I24	A3-D01	Row 14, Col 0
A1-I31	A1-D01	Row 0, Col 5
A1-I31	A2-D01	Row 0, Col 0
A1-I31	B2-D02	Row 2, Col 2
A1-I31	D2-D01	Row 6, Col 4
A1-I31	D2-D01	Row 8, Col 3
A1-I31	D3-D02	Row 0, Col 1
A1-I31	D3-D02	Row 4, Col 2

Name	**Diagram**	**Location**
A1-F02	A1-D01	Row 10, Col 1
A1-F02	A1-D01	Row 12, Col 0
A1-F02	A1-D01	Row 2, Col 0
A1-F02	A1-D01	Row 3, Col 0
A1-F02	A1-D01	Row 8, Col 0
A1-F03	A1-D01	Row 10, Col 2
A1-F04	A1-D01	Row 2, Col 1

Name	**Diagram**	**Location**
A1-C01	A1-D01	Row 4, Col 0
A1-C02	A1-D01	Row 6, Col 0
A1-C03	A1-D01	Row 12, Col 1
A1-C04	A1-D01	Row 3, Col 1
A1-C05	A1-D01	Row 10, Col 3
A1-C06	A1-D01	Row 8, Col 1
A1-C07	A1-D01	Row 14, Col 1
A1-C08	A1-D02	Row 0, Col 1
A1-C09	A1-D02	Row 2, Col 0
A1-C10	A1-D02	Row 4, Col 0
A1-C11	A1-D02	Row 6, Col 0

Designer: Paul Boulet Project Name: M450LXI REV A

Cross Reference for **A2** **Type:** DIO 8/8

Name	Diagram	Location
A2-I01	A3-D02	Row 2, Col 0
A2-I02	A2-D01	Row 14, Col 0
A2-I03	D3-D01	Row 4, Col 2
A2-I04	D3-D02	Row 13, Col 2
A2-I05	A2-D01	Row 9, Col 1
A2-I08	B1-D01	Row 3, Col 1

Name	Diagram	Location
A2-T03	A2-D01	Row 9, Col 2

Designer: Paul Boulet Project Name: M450LXI REV A

Cross Reference for **A3** **Type:** DIO 8/8

Name	Diagram	Location
A3-I01	GO-D01	Row 0, Col 0
A3-I01	GO-D01	Row 2, Col 1
A3-I01	GO-D01	Row 4, Col 1
A3-I01	GO-D01	Row 6, Col 1
A3-I01	GO-D01	Row 8, Col 1
A3-I02	GO-D01	Row 2, Col 0
A3-I02	GO-D01	Row 4, Col 2
A3-I02	GO-D01	Row 6, Col 2
A3-I02	GO-D01	Row 8, Col 0
A3-I03	GO-D01	Row 4, Col 0
A3-I03	GO-D01	Row 6, Col 0
A3-I04	A4-D02	Row 7, Col 0
A3-I04	D3-D01	Row 6, Col 1
A3-I04	D3-D01	Row 8, Col 1
A3-I05	D3-D01	Row 6, Col 2
A3-I06	D3-D01	Row 8, Col 2
A3-I07	D3-D01	Row 7, Col 2
A3-I07	D3-D01	Row 9, Col 2
A3-I08	D3-D02	Row 0, Col 3

Designer: Paul Boulet Project Name: M450LXI REV A

Cross Reference for **A4** **Type:** DIO 8/8

Name	Diagram	Location
A4-I02	D3-D02	Row 8, Col 3

Designer: Paul Boulet Project Name: M450LXI REV A

Cross Reference for **B1** **Type:** DIO 8/8

Name	Diagram	Location
B1-I01	A3-D02	Row 0, Col 0
B1-I01	B1-D01	Row 2, Col 2
B1-I01	B1-D01	Row 5, Col 2
B1-I01	B2-D01	Row 0, Col 3
B1-I02	B1-D01	Row 7, Col 1
B1-I02	D1-D01	Row 5, Col 1
B1-I03	B1-D01	Row 11, Col 1
B1-I03	D1-D01	Row 7, Col 1
B1-I07	A1-D01	Row 1, Col 0
B1-I07	D1-D01	Row 3, Col 0
B1-I07	D3-D01	Row 4, Col 1
B1-I07	D3-D02	Row 4, Col 1
B1-I08	A1-D01	Row 0, Col 4
B1-I08	A3-D01	Row 14, Col 1
B1-I08	A3-D01	Row 7, Col 0
B1-I08	A4-D02	Row 0, Col 0
B1-I08	A4-D02	Row 5, Col 0
B1-I08	B2-D02	Row 2, Col 1
B1-I08	B2-D02	Row 4, Col 0
B1-I08	D2-D01	Row 7, Col 0
B1-I08	D2-D01	Row 9, Col 0
B1-I08	D2-D02	Row 4, Col 1
B1-I08	D3-D02	Row 0, Col 2

Name	Diagram	Location
B1-O03	A2-D01	Row 4, Col 0
B1-O04	A2-D01	Row 11, Col 0

Name	Diagram	Location
B1-T01	B1-D01	Row 0, Col 0

Name	Diagram	Location
B1-F01	B1-D01	Row 11, Col 2
B1-F01	B1-D01	Row 7, Col 2
B1-F01	D1-D01	Row 5, Col 2
B1-F01	D1-D01	Row 7, Col 2

Designer: Paul Boulet Project Name: M450LXI REV A

Cross Reference for **B2** **Type:** DIO 8/8

Name	Diagram	Location
B2-I05	B2-D01	Row 0, Col 2

Designer: Paul Boulet Project Name: M450LXI REV A

Cross Reference for **D1** **Type:** DIO 8/8

Name	Diagram	Location
D1-I01	A4-D03	Row 4, Col 0
D1-I02	A1-D01	Row 0, Col 2
D1-I03	A1-D01	Row 0, Col 3
D1-I04	D2-D01	Row 14, Col 1

Designer: Paul Boulet Project Name: M450LXI REV A

Cross Reference for **D2** **Type:** DIO 8/8

Name	Diagram	Location
D2-I01	D2-D01	Row 6, Col 2
D2-I01	D2-D01	Row 8, Col 2
D2-I01	D2-D02	Row 3, Col 1
D2-I02	D2-D01	Row 7, Col 1
D2-I02	D2-D01	Row 9, Col 1
D2-I02	D2-D02	Row 4, Col 0
D2-I02	D3-D01	Row 2, Col 0
D2-I02	D3-D02	Row 0, Col 4
D2-I02	D3-D02	Row 8, Col 2
D2-I03	D2-D01	Row 7, Col 2
D2-I03	D2-D01	Row 9, Col 2
D2-I04	D2-D01	Row 6, Col 3

Name	Diagram	Location
D2-O03	D2-D01	Row 8, Col 4
D2-O03	D2-D01	Row 9, Col 3

Name	Diagram	Location
D2-T01	D2-D01	Row 6, Col 7
D2-T02	D2-D02	Row 8, Col 3

Designer: Paul Boulet Project Name: M450LXI REV A

Cross Reference for **D3** **Type:** DIO 8/8

Name	Diagram	Location
D3-I01	A1-D01	Row 0, Col 1
D3-I01	A3-D01	Row 10, Col 1
D3-I01	A3-D01	Row 2, Col 0
D3-I07	A2-D01	Row 2, Col 0
D3-I07	D1-D02	Row 3, Col 1

Name	Diagram	Location
D3-O05	D3-D01	Row 1, Col 0
D3-O05	D3-D02	Row 8, Col 1

Designer: Paul Boulet Project Name: M450LXI REV A

Cross Reference for **GI** **Type:** DIO 0/32

Name	Diagram	Location
GI-F05	A4-D03	Row 0, Col 0
GI-F06	A4-D03	Row 2, Col 0

Name	Diagram	Location
GI-C01	GI-D01	Row 0, Col 0
GI-C02	GI-D01	Row 2, Col 0
GI-C03	GI-D01	Row 4, Col 0
GI-C04	GI-D01	Row 6, Col 0
GI-C05	GI-D01	Row 8, Col 0
GI-C06	GI-D01	Row 10, Col 0

Designer: Paul Boulet Project Name: M450LXI REV A

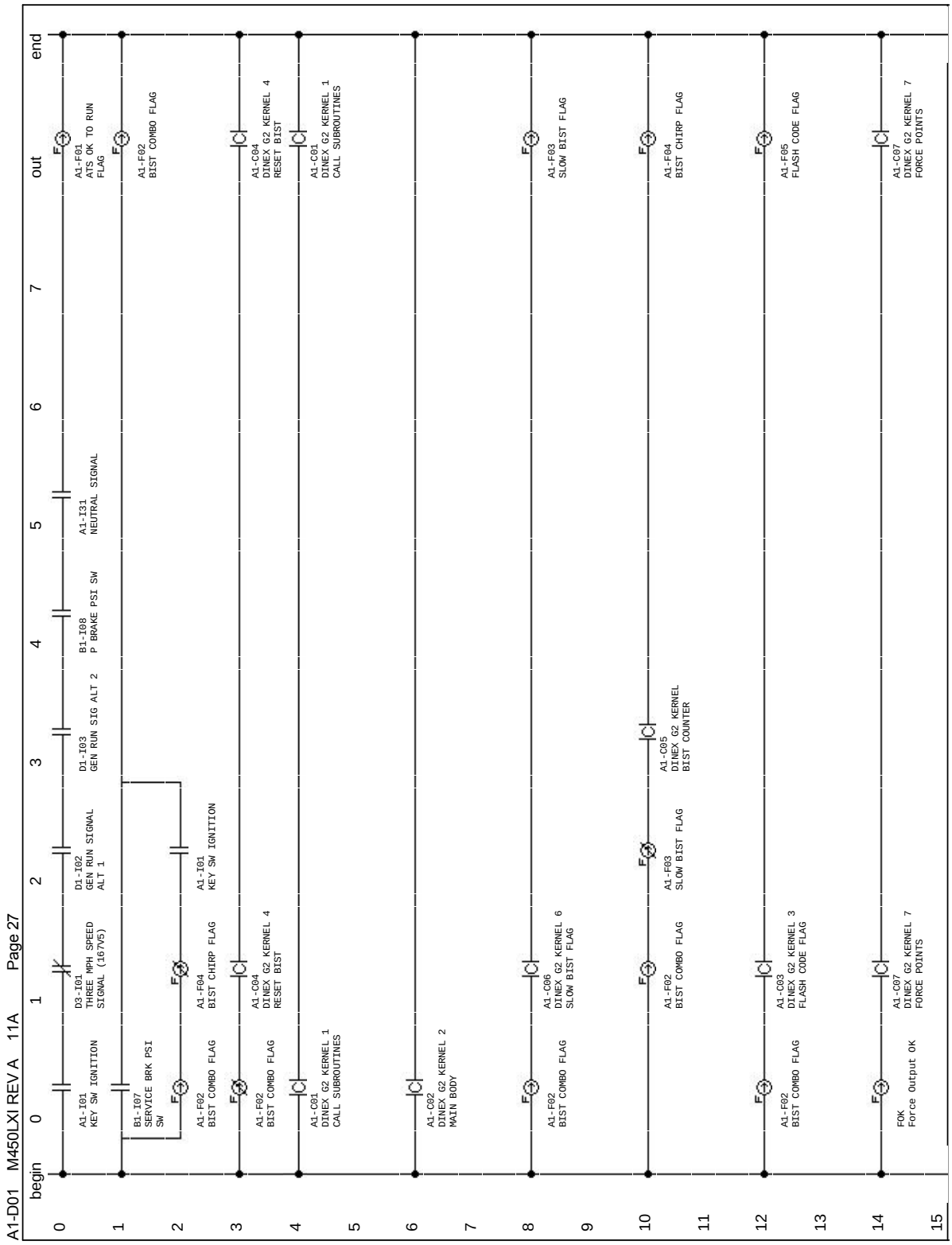
Cross Reference for **GO** **Type:** DIO 0/32

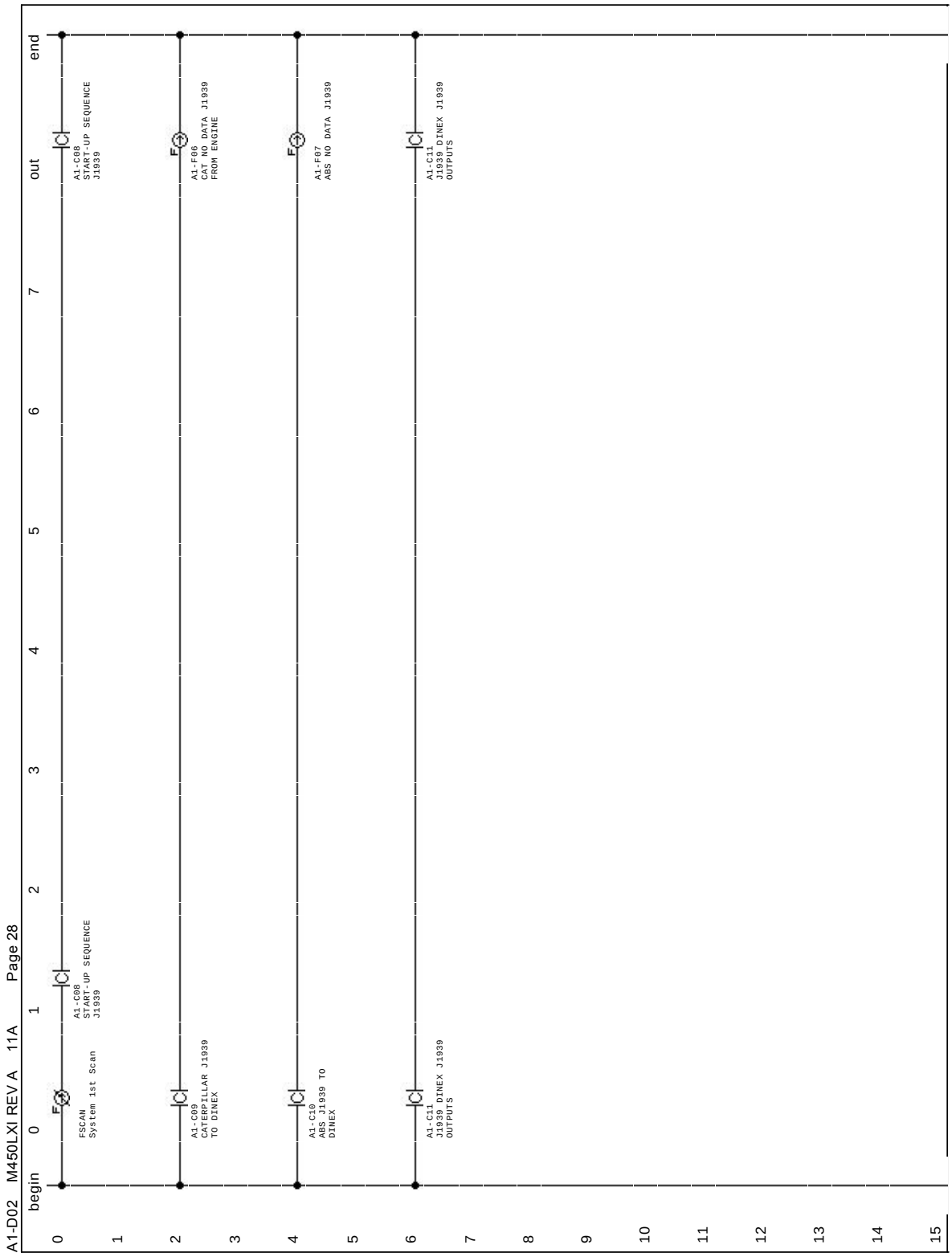
Name	Diagram	Location
GO-C01	GO-D01	Row 0, Col 4
GO-C02	GO-D01	Row 2, Col 4
GO-C03	GO-D01	Row 4, Col 4
GO-C04	GO-D01	Row 6, Col 4
GO-C05	GO-D01	Row 8, Col 4
GO-C32	GO-D01	Row 11, Col 0

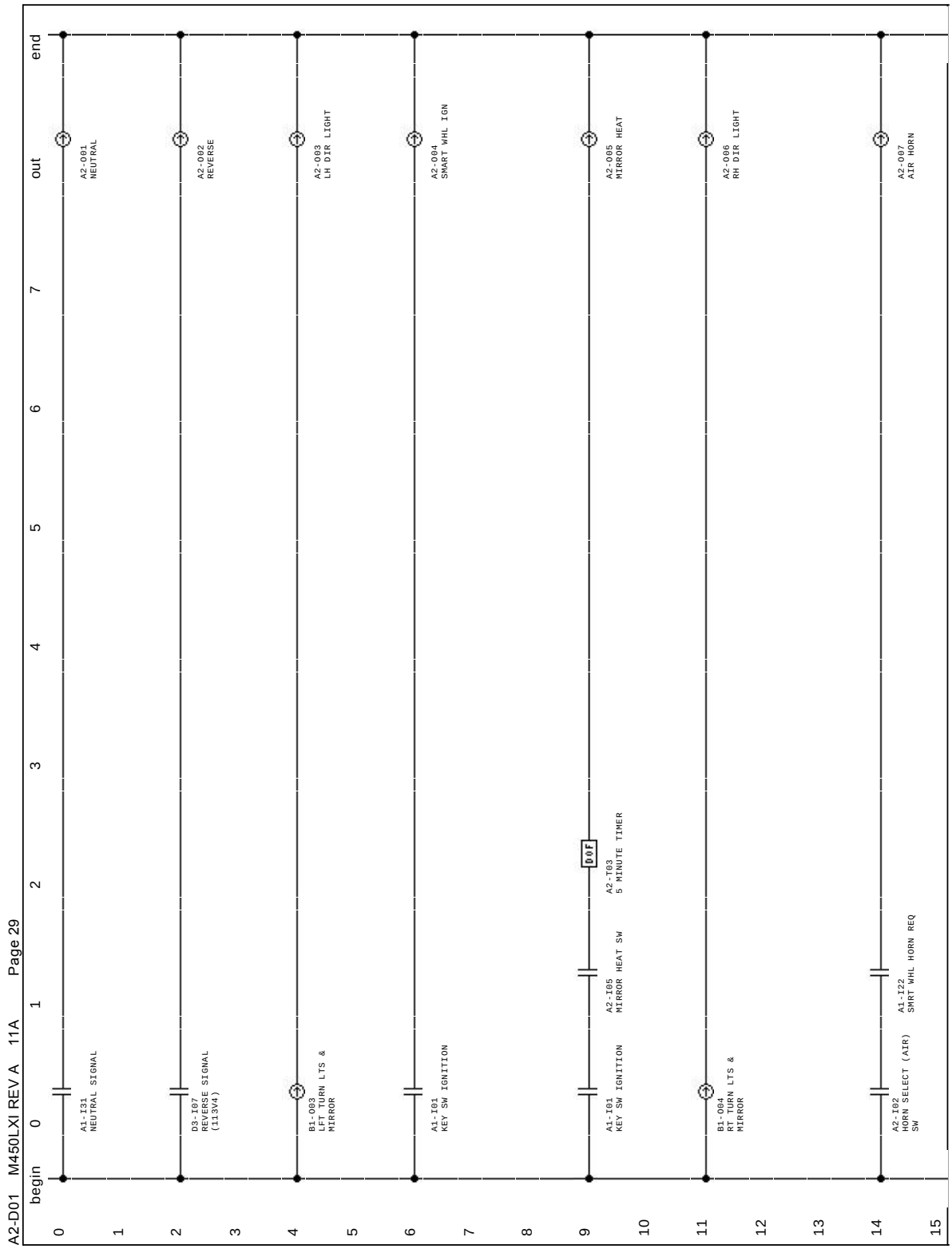
Designer: Paul Boulet Project Name: M450LXI REV A

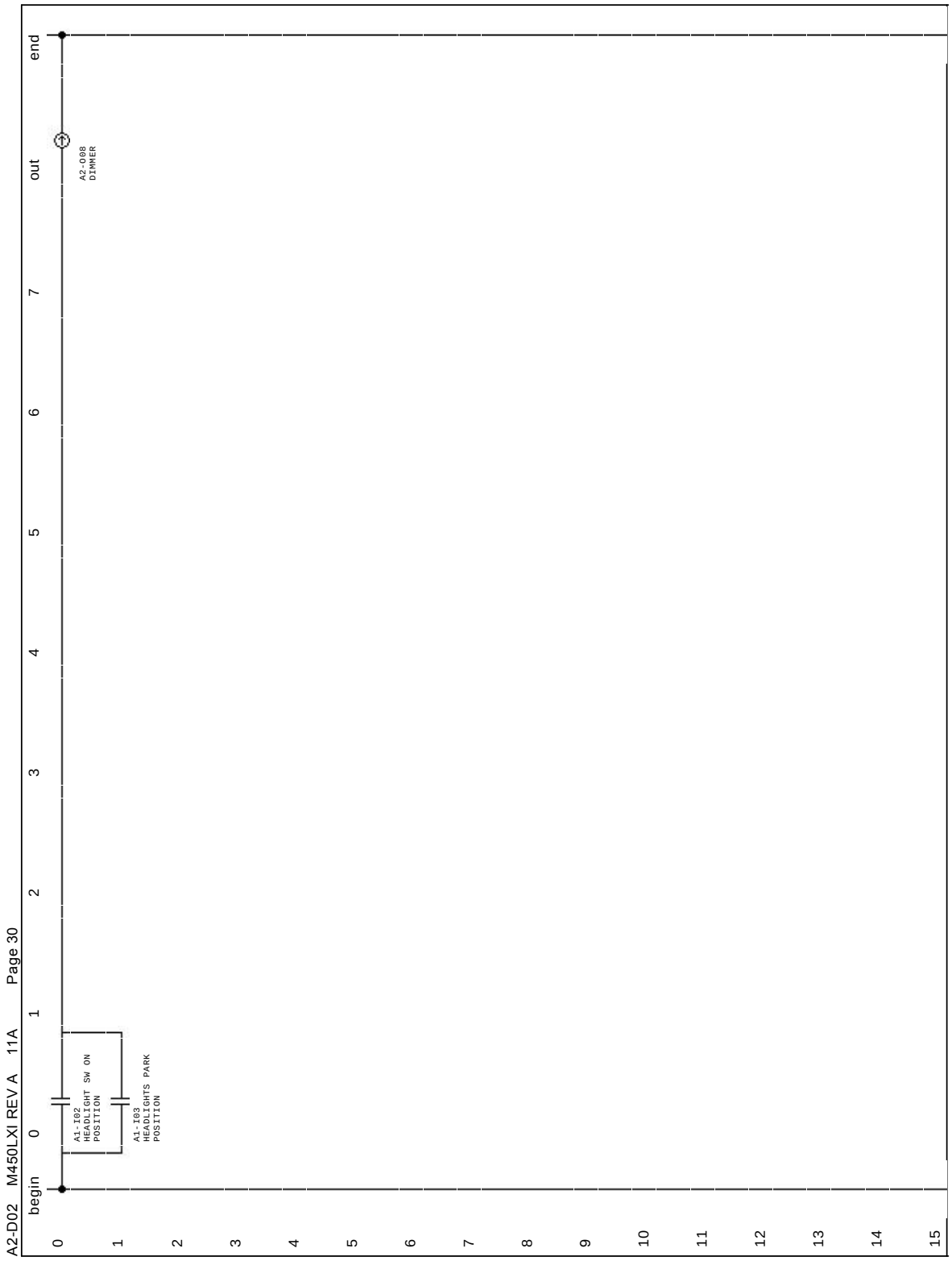
Cross Reference for **System** **Type:** System

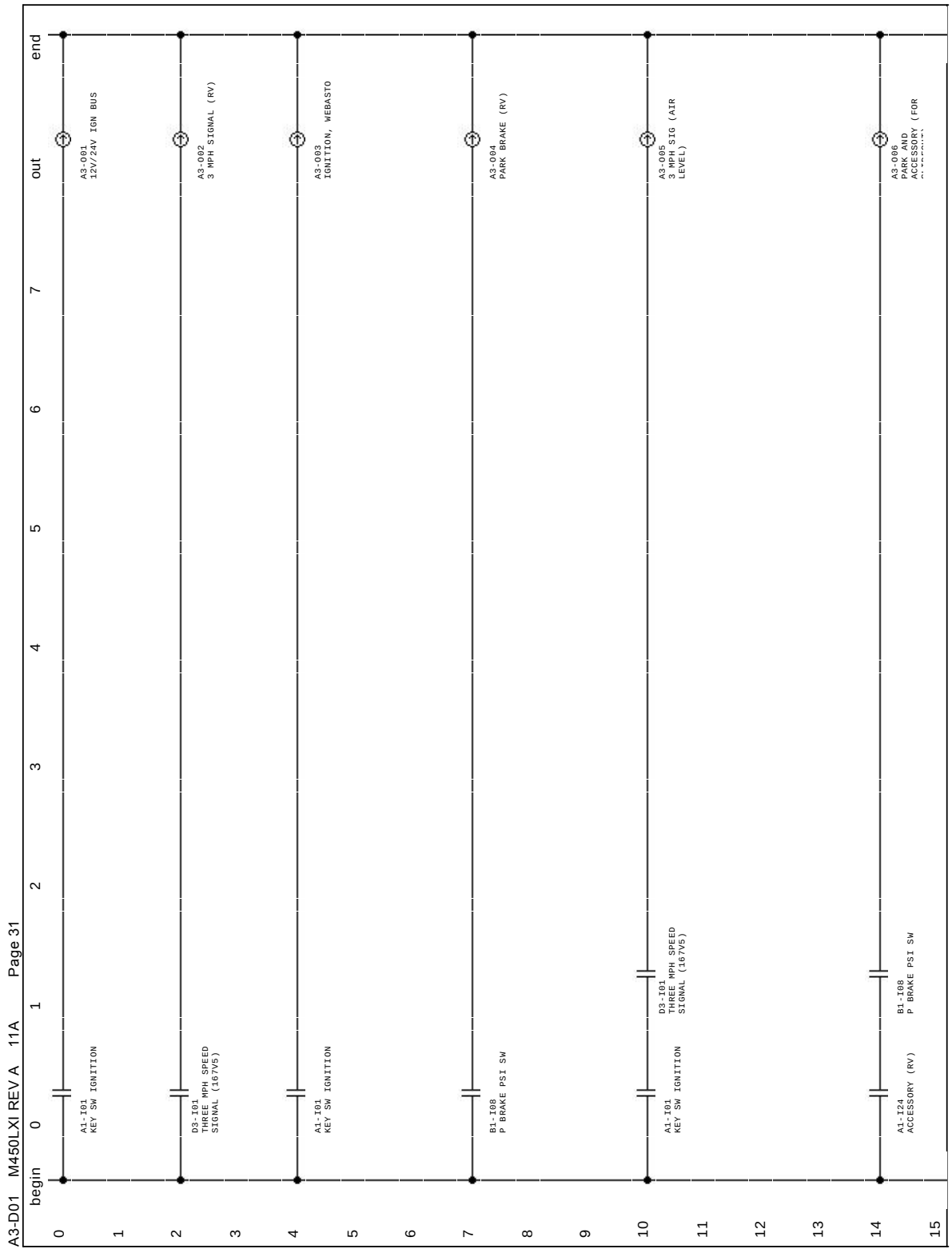
Name	Diagram	Location
FOK	A1-D01	Row 14, Col 0
FSCAN	A1-D02	Row 0, Col 0

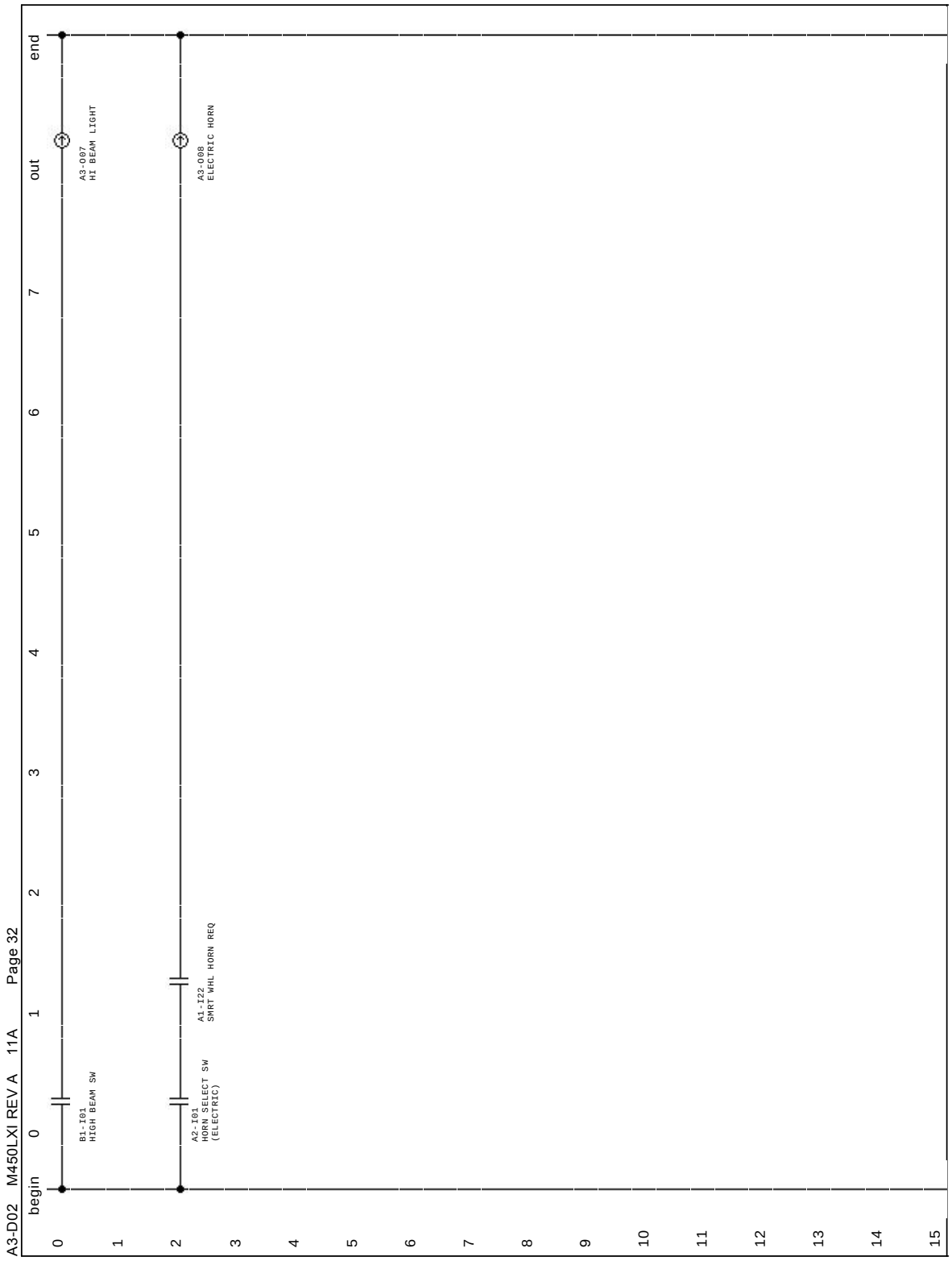

A1-D01 M450LXI REV A 11A Page 27
begin
0
1
2
3
4
5
6
7
out
end
A1-I01
KEY SW IGNITION
D3-I01
THREE MPH SPEED
SIGNAL (167V5)
D1-I02
GEN RUN SIGNAL
ALT 1
D1-I03
GEN RUN SIG ALT 2
B1-I08
P BRAKE PSI SW
A1-I31
NEUTRAL SIGNAL
A1-F01
ATS OK TO RUN
FLAG
B1-I07
SERVICE BRK PSI
SW
A1-F02
BIST COMBO FLAG
A1-F04
BIST CHIRP FLAG
A1-I01
KEY SW IGNITION
A1-F02
BIST COMBO FLAG
A1-C04
DINEX G2 KERNEL 4
RESET BIST
A1-C01
DINEX G2 KERNEL 1
CALL SUBROUTINES
A1-F02
BIST COMBO FLAG
A1-C01
DINEX G2 KERNEL 1
CALL SUBROUTINES
A1-C02
DINEX G2 KERNEL 2
MAIN BODY
A1-F02
BIST COMBO FLAG
A1-C06
DINEX G2 KERNEL 6
SLOW BIST FLAG
A1-F03
SLOW BIST FLAG
A1-F02
BIST COMBO FLAG
A1-F03
SLOW BIST FLAG
A1-C05
DINEX G2 KERNEL
BIST COUNTER
A1-F04
BIST CHIRP FLAG
A1-F02
BIST COMBO FLAG
A1-C03
DINEX G2 KERNEL 3
FLASH CODE FLAG
A1-F05
FLASH CODE FLAG
FOK
Force Output OK
A1-C07
DINEX G2 KERNEL 7
FORCE POINTS
A1-C07
DINEX G2 KERNEL 7
FORCE POINTS

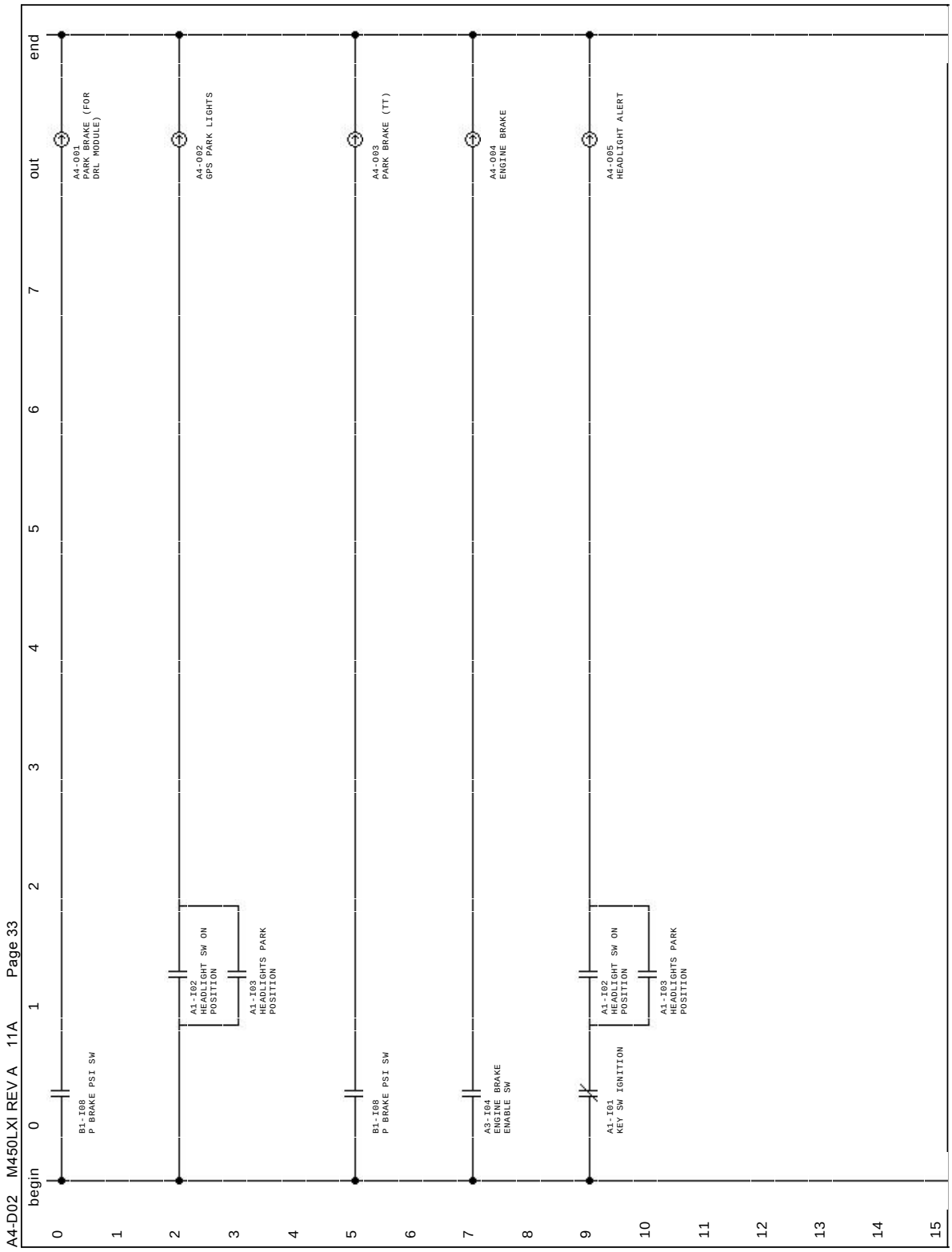

A1-D02 M450LXI REV A 11A Page 28
begin 0 1 2 3 4 5 6 7 out end
FSCAN
System 1st Scan
A1-C08
START-UP SEQUENCE
J1939
A1-C09
CATERPILLAR J1939
TO DINEX
A1-C10
ABS J1939 TO
DINEX
A1-C11
J1939 DINEX J1939
OUTPUTS
A1-F06
CAT NO DATA J1939
FROM ENGINE
A1-F07
ABS NO DATA J1939
A1-C11
J1939 DINEX J1939
OUTPUTS
A1-C08
START-UP SEQUENCE
J1939
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15

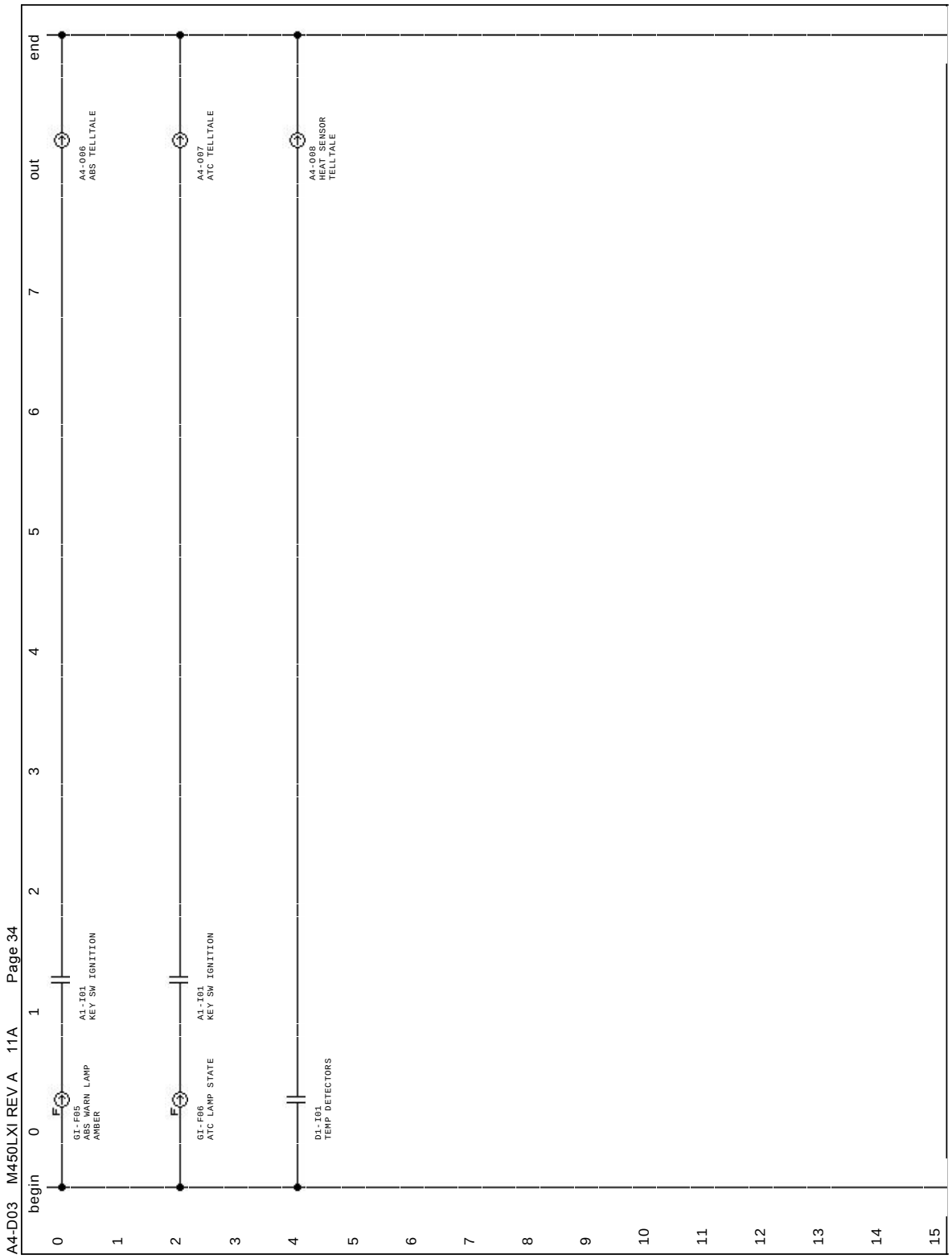

A2-D01 M450LXI REV A 11A Page 29
begin 0 1 2 3 4 5 6 7 out end
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
A1-I31
NEUTRAL SIGNAL
A2-001
NEUTRAL
D3-I07
REVERSE SIGNAL
(113V4)
A2-002
REVERSE
B1-003
LFT TURN LTS &
MIRROR
A2-003
LH DIR LIGHT
A1-I01
KEY SW IGNITION
A2-004
SMART WHL IGN
A1-I01
KEY SW IGNITION
A2-I05
MIRROR HEAT SW
DOF
A2-T03
5 MINUTE TIMER
A2-005
MIRROR HEAT
B1-004
RT TURN LTS &
MIRROR
A2-006
RH DIR LIGHT
A2-I02
HORN SELECT (AIR)
SW
A1-I22
SMRT WHL HORN REQ
A2-007
AIR HORN

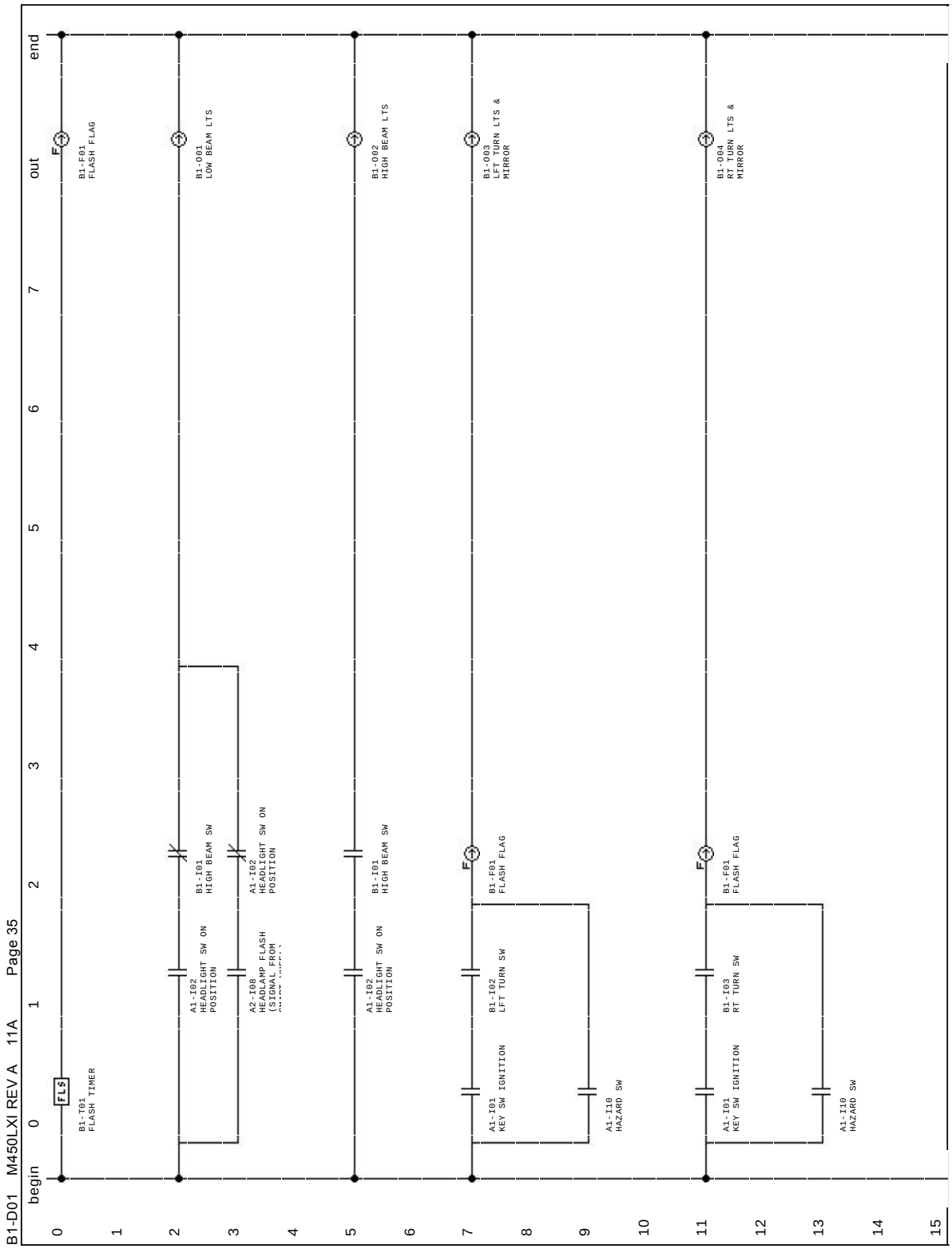

A2-D02 M450LXI REV A 11A Page 30
begin
out
end
A1-I02
HEADLIGHT SW ON
POSITION
A1-I03
HEADLIGHTS PARK
POSITION
A2-O08
DIMMER
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15

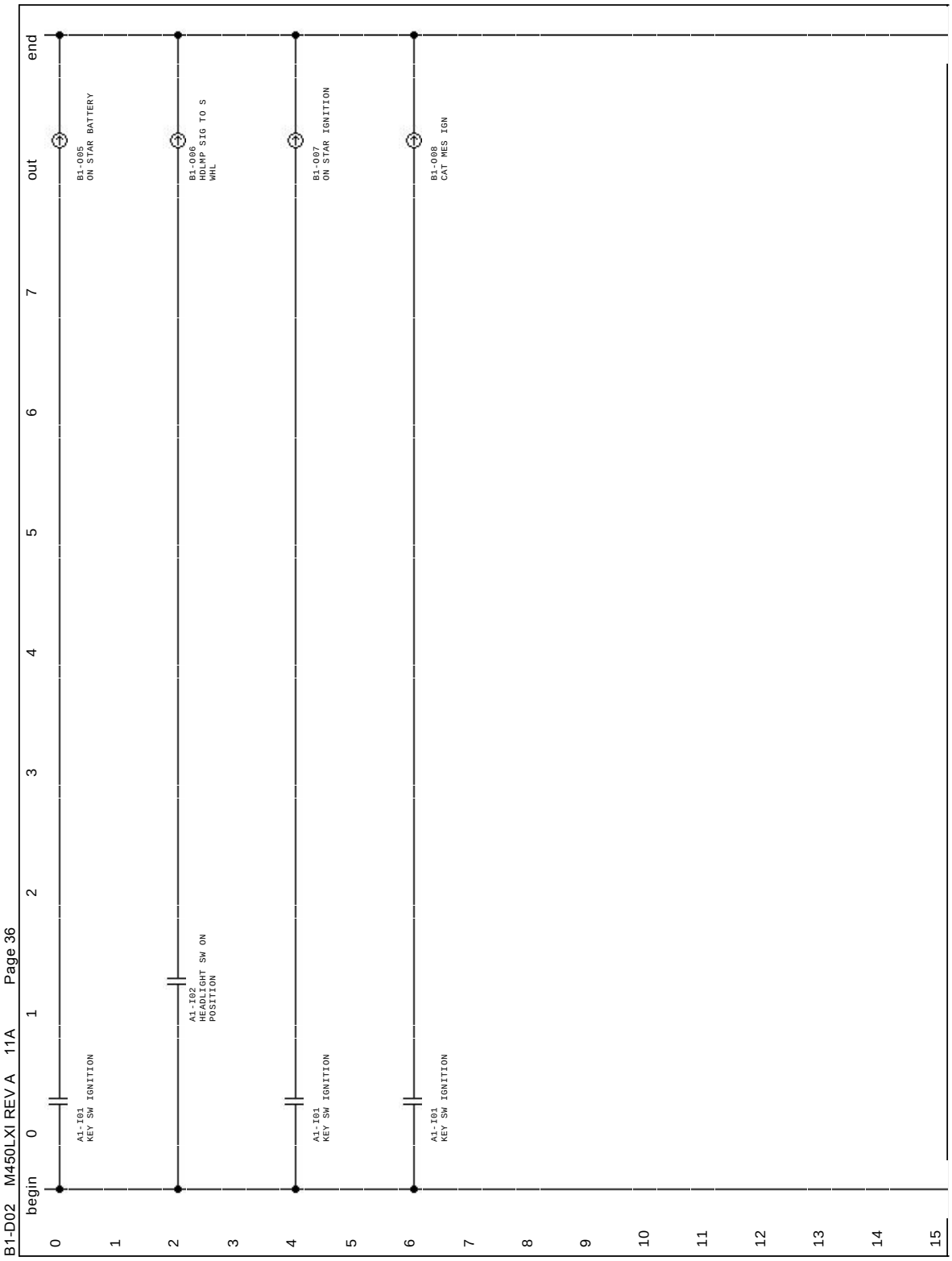

A3-D01 M450LXI REV A 11A Page 31
begin
out
end
A1-I01
KEY SW IGNITION
D3-I01
THREE MPH SPEED
SIGNAL (167V5)
A1-I01
KEY SW IGNITION
B1-I08
P BRAKE PSI SW
A1-I01
KEY SW IGNITION
D3-I01
THREE MPH SPEED
SIGNAL (167V5)
A1-I24
ACCESSORY (RV)
B1-I08
P BRAKE PSI SW
A3-001
12V/24V IGN BUS
A3-002
3 MPH SIGNAL (RV)
A3-003
IGNITION, WEBASTO
A3-004
PARK BRAKE (RV)
A3-005
3 MPH SIG (AIR
LEVEL)
A3-006
PARK AND

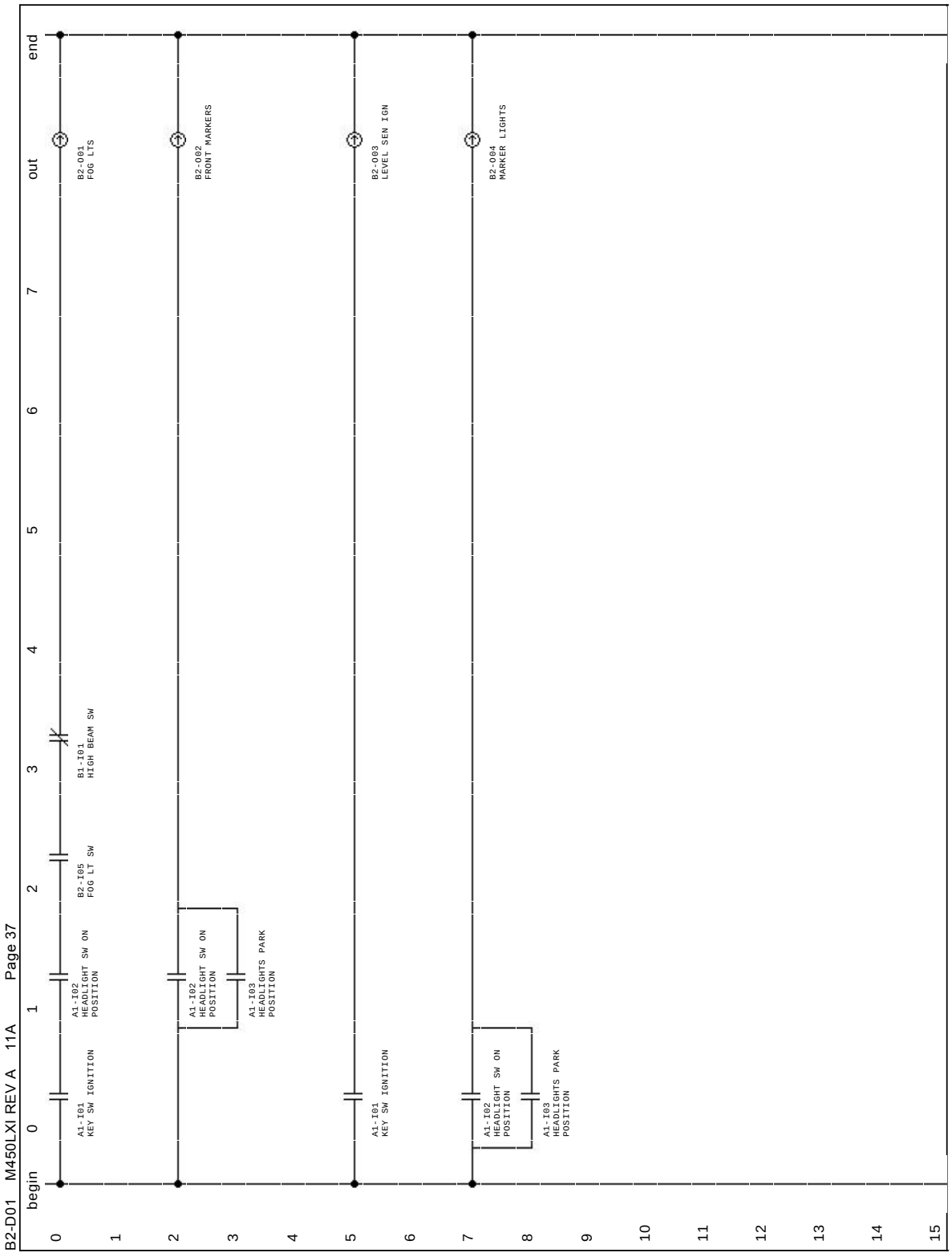

A3-D02 M450LXI REV A 11A Page 32
begin
0
1
2
3
4
5
6
7
out
end
B1-I01
HIGH BEAM SW
A2-I01
HORN SELECT SW
(ELECTRIC)
A4-I22
SMRT WHL HORN REQ
A3-007
HI BEAM LIGHT
A3-008
ELECTRIC HORN
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15

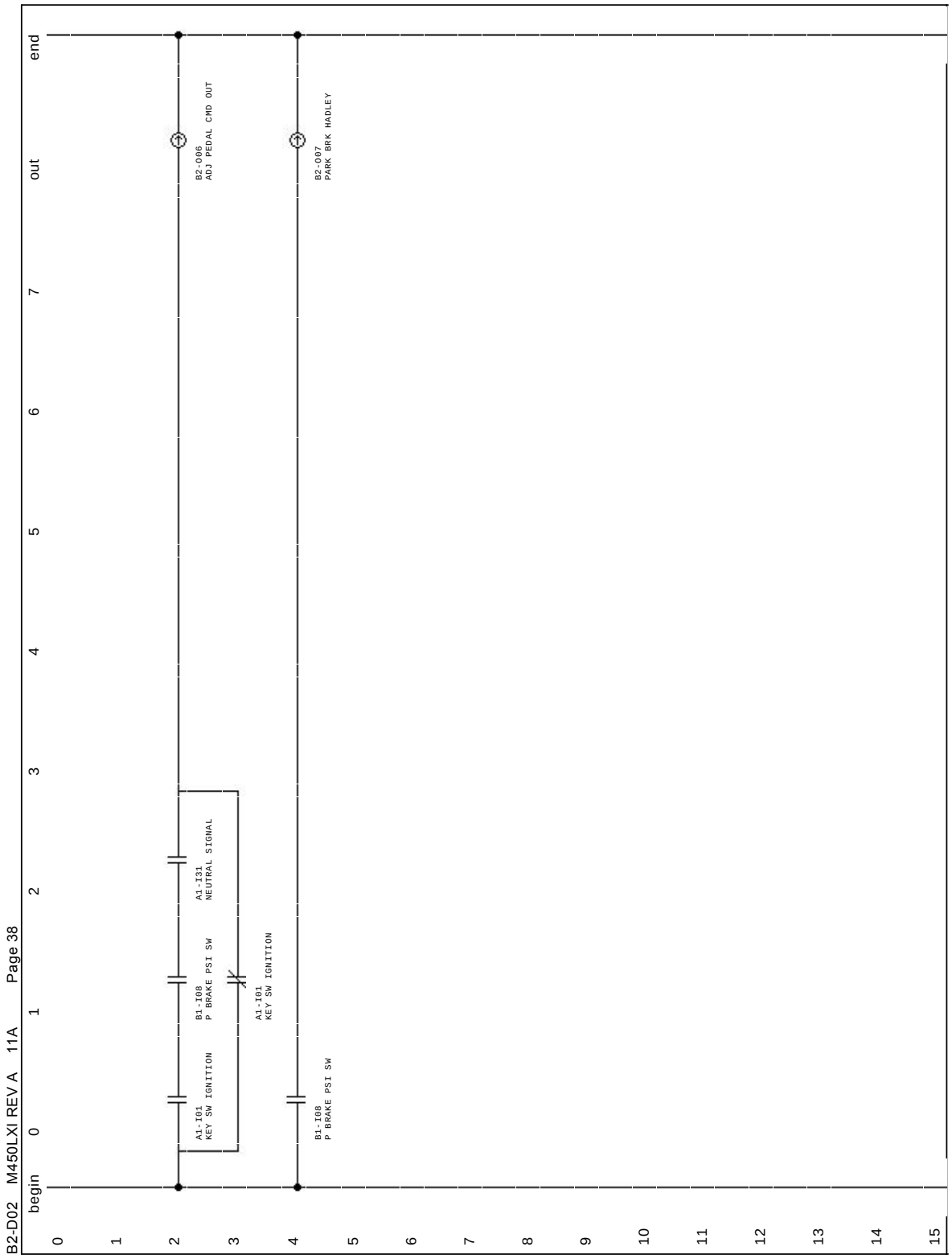

A4-D02 M450LXI REV A 11A Page 33
begin
0
1
2
3
4
5
6
7
out
end
B1-I08
P BRAKE PSI SW
A1-I02
HEADLIGHT SW ON
POSITION
A1-I03
HEADLIGHTS PARK
POSITION
B1-I08
P BRAKE PSI SW
A3-I04
ENGINE BRAKE
ENABLE SW
A1-I01
KEY SW IGNITION
A1-I02
HEADLIGHT SW ON
POSITION
A1-I03
HEADLIGHTS PARK
POSITION
A4-O01
PARK BRAKE (FOR
DRL MODULE)
A4-O02
GPS PARK LIGHTS
A4-O03
PARK BRAKE (TT)
A4-O04
ENGINE BRAKE
A4-O05
HEADLIGHT ALERT
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15

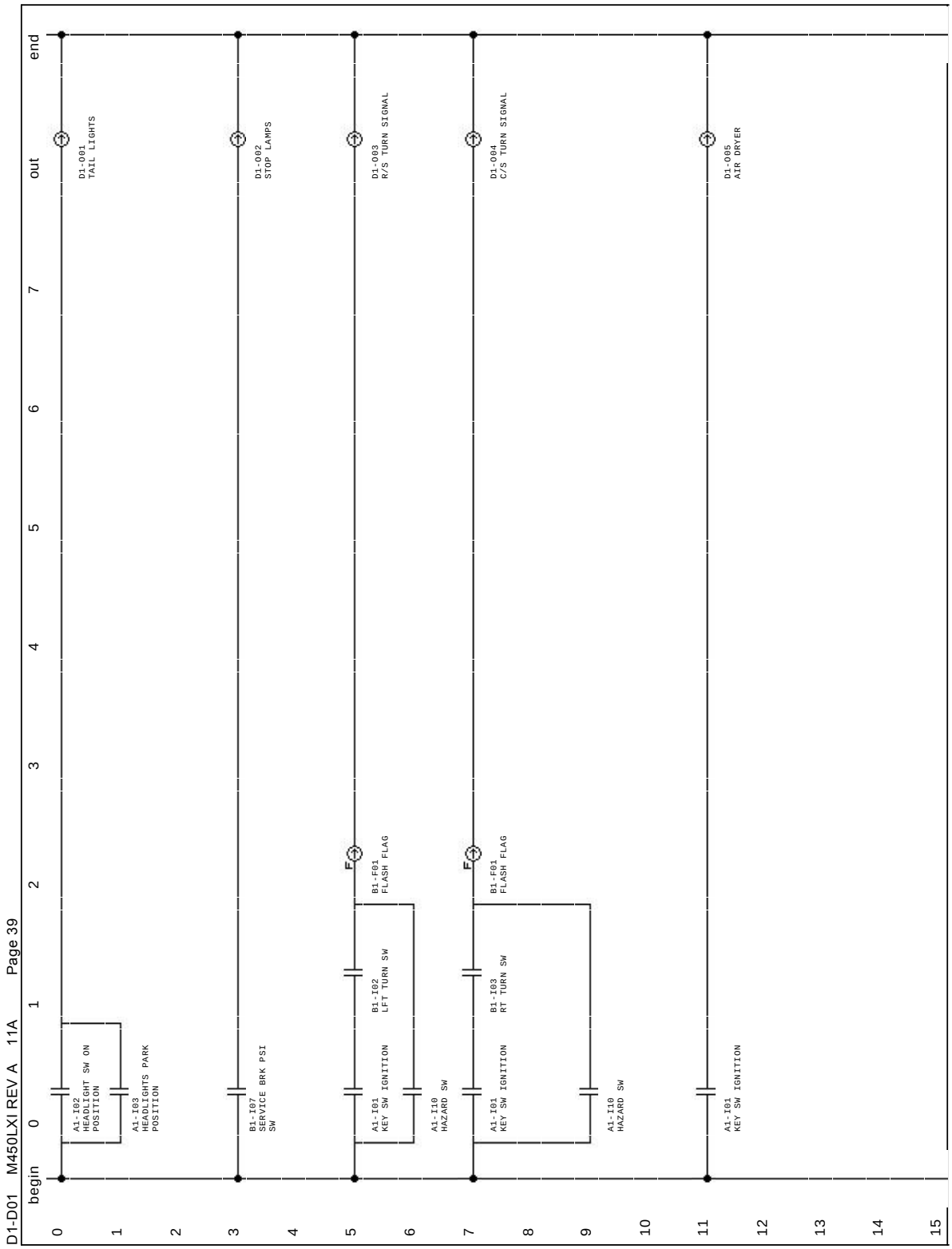

A4-D03 M450LXI REV A 11A Page 34
begin 0 1 2 3 4 5 6 7 out end
GI-F05
ABS WARN LAMP
AMBER
A1-I01
KEY SW IGNITION
A4-O06
ABS TELLTALE
GI-F06
ATC LAMP STATE
A1-I01
KEY SW IGNITION
A4-O07
ATC TELLTALE
D1-I01
TEMP DETECTORS
A4-O08
HEAT SENSOR
TELLTALE
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15

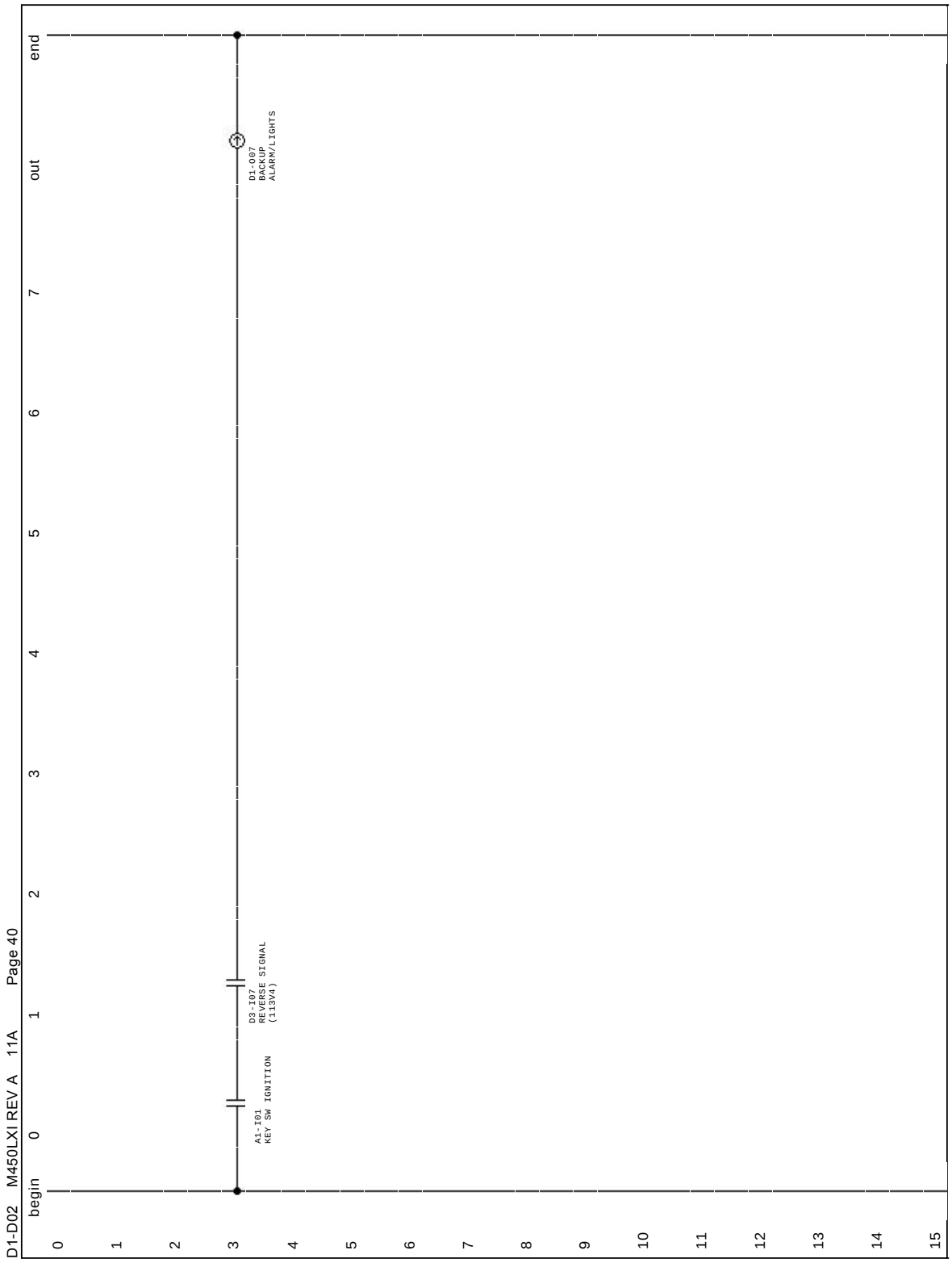

B1-D01 M450LXI REV A 11A Page 35
begin
out
end
B1-T01
FLASH TIMER
FL5
B1-F01
FLASH FLAG
B1-O01
LOW BEAM LTS
B1-O02
HIGH BEAM LTS
B1-O03
LFT TURN LTS &
MIRROR
B1-O04
RT TURN LTS &
MIRROR
A1-I02
HEADLIGHT SW ON
POSITION
B1-I01
HIGH BEAM SW
A2-I08
HEADLAMP FLASH
A1-I02
HEADLIGHT SW ON
POSITION
A1-I01
KEY SW IGNITION
B1-I02
LFT TURN SW
A1-I10
HAZARD SW
B1-I03
RT TURN SW

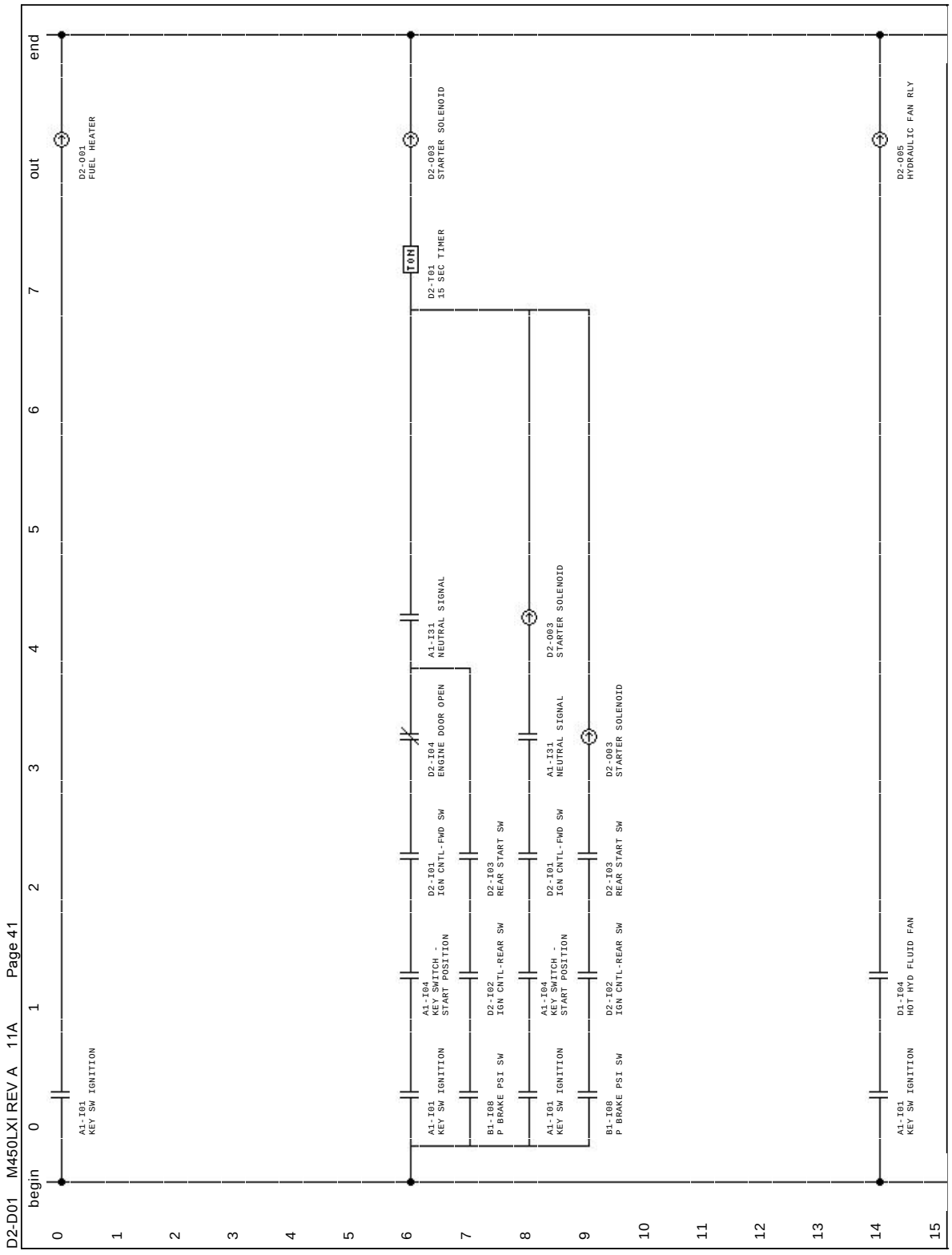

B1-D02 M450LXI REV A 11A Page 36
begin
out
end
A1-I01
KEY SW IGNITION
A1-I02
HEADLIGHT SW ON
POSITION
A1-I01
KEY SW IGNITION
A1-I01
KEY SW IGNITION
B1-O05
ON STAR BATTERY
B1-O06
HDLMP SIG TO S
WHL
B1-O07
ON STAR IGNITION
B1-O08
CAT MES IGN

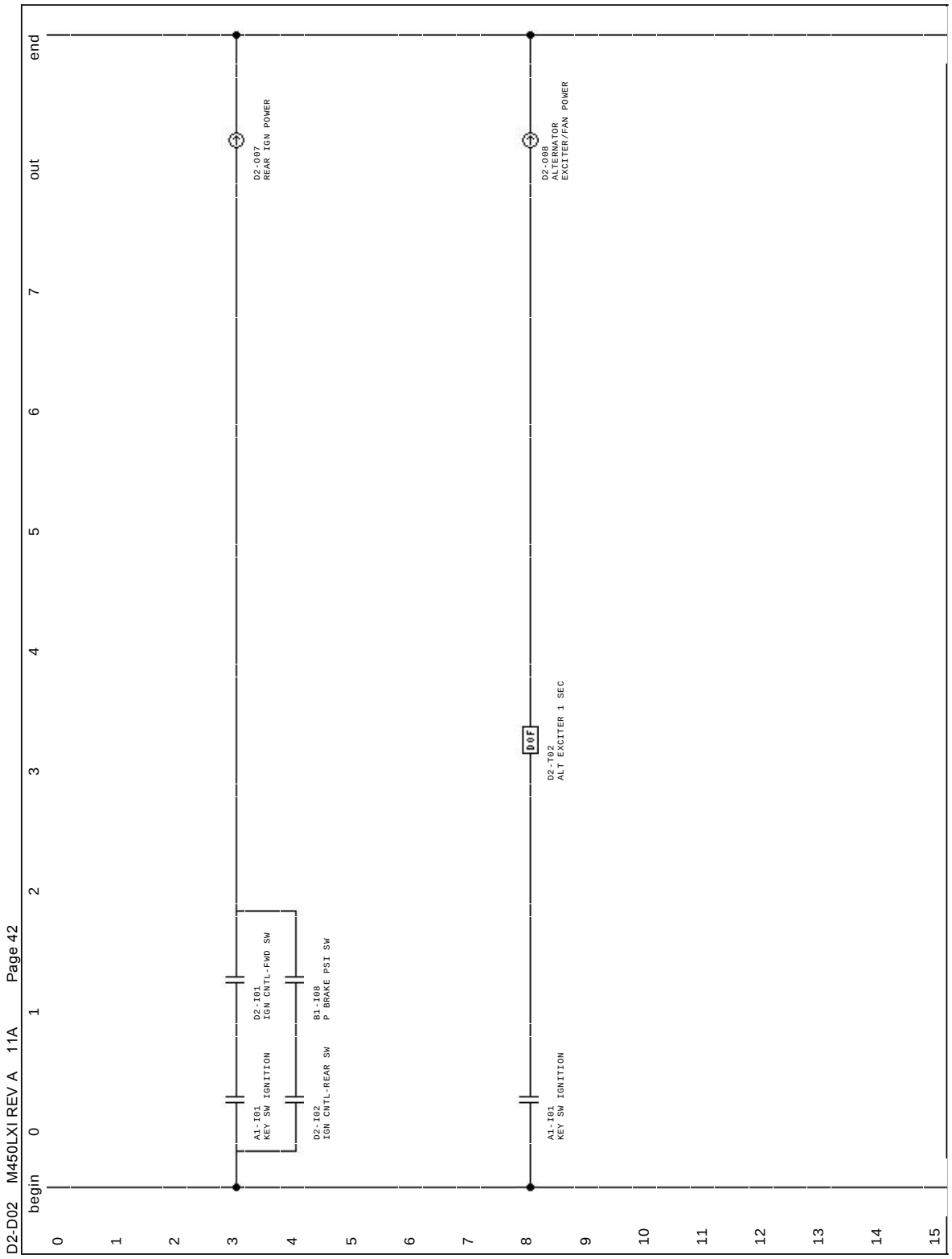

B2-D01 M450LXI REV A 11A Page 37
begin
0
1
2
3
4
5
6
7
out
end
A1-I01
KEY SW IGNITION
A1-I02
HEADLIGHT SW ON
POSITION
B2-I05
FOG LT SW
B1-I01
HIGH BEAM SW
B2-O01
FOG LTS
A1-I02
HEADLIGHT SW ON
POSITION
A1-I03
HEADLIGHTS PARK
POSITION
B2-O02
FRONT MARKERS
A1-I01
KEY SW IGNITION
B2-O03
LEVEL SEN IGN
A1-I02
HEADLIGHT SW ON
POSITION
A1-I03
HEADLIGHTS PARK
POSITION
B2-O04
MARKER LIGHTS
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15

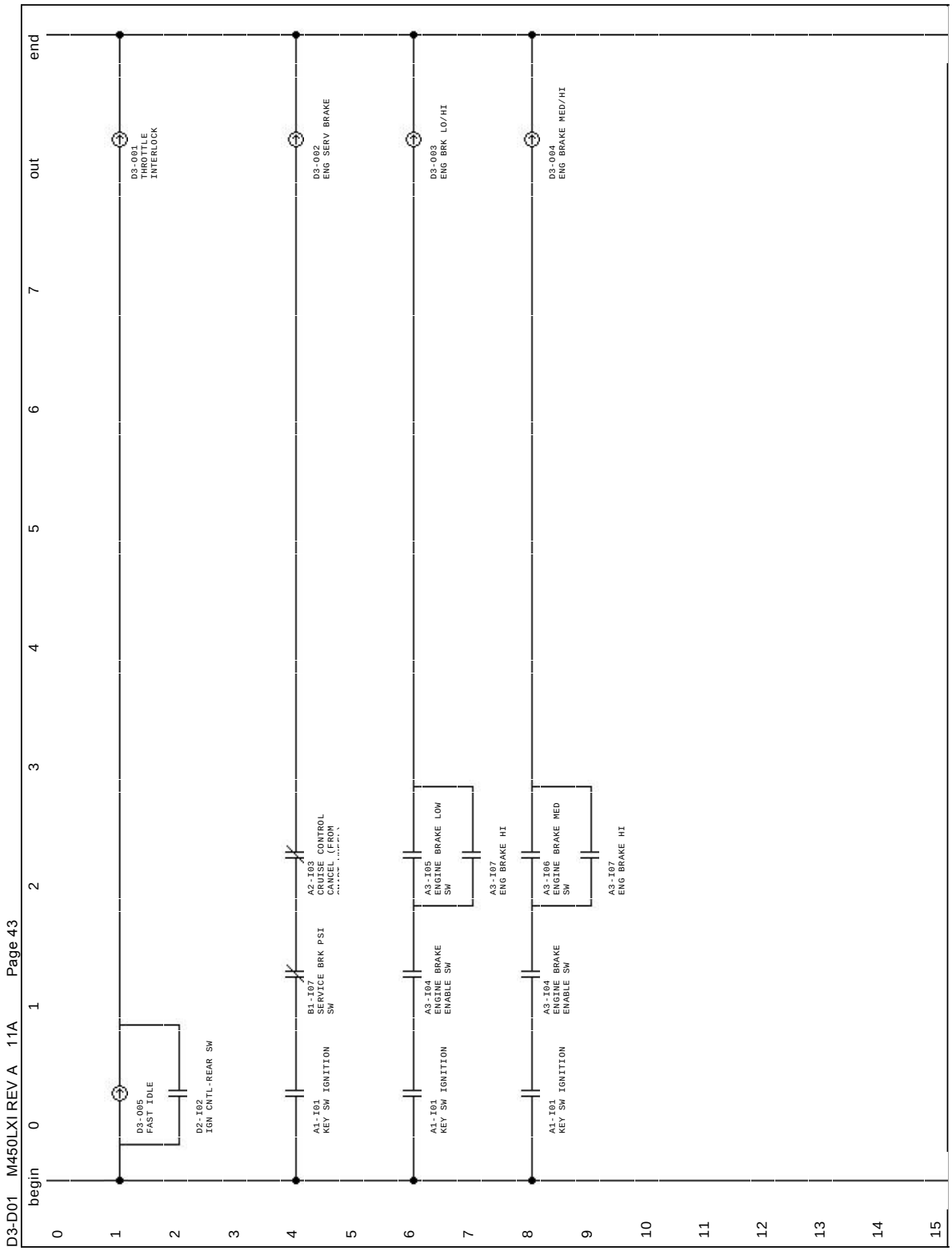

B2-D02 M450LXI REV A 11A Page 38
begin
out
end
A1-I01
KEY SW IGNITION
B1-I08
P BRAKE PSI SW
A1-I31
NEUTRAL SIGNAL
B2-O06
ADJ PEDAL CMD OUT
B2-O07
PARK BRK HADLEY
A1-I01
KEY SW IGNITION
B1-I08
P BRAKE PSI SW

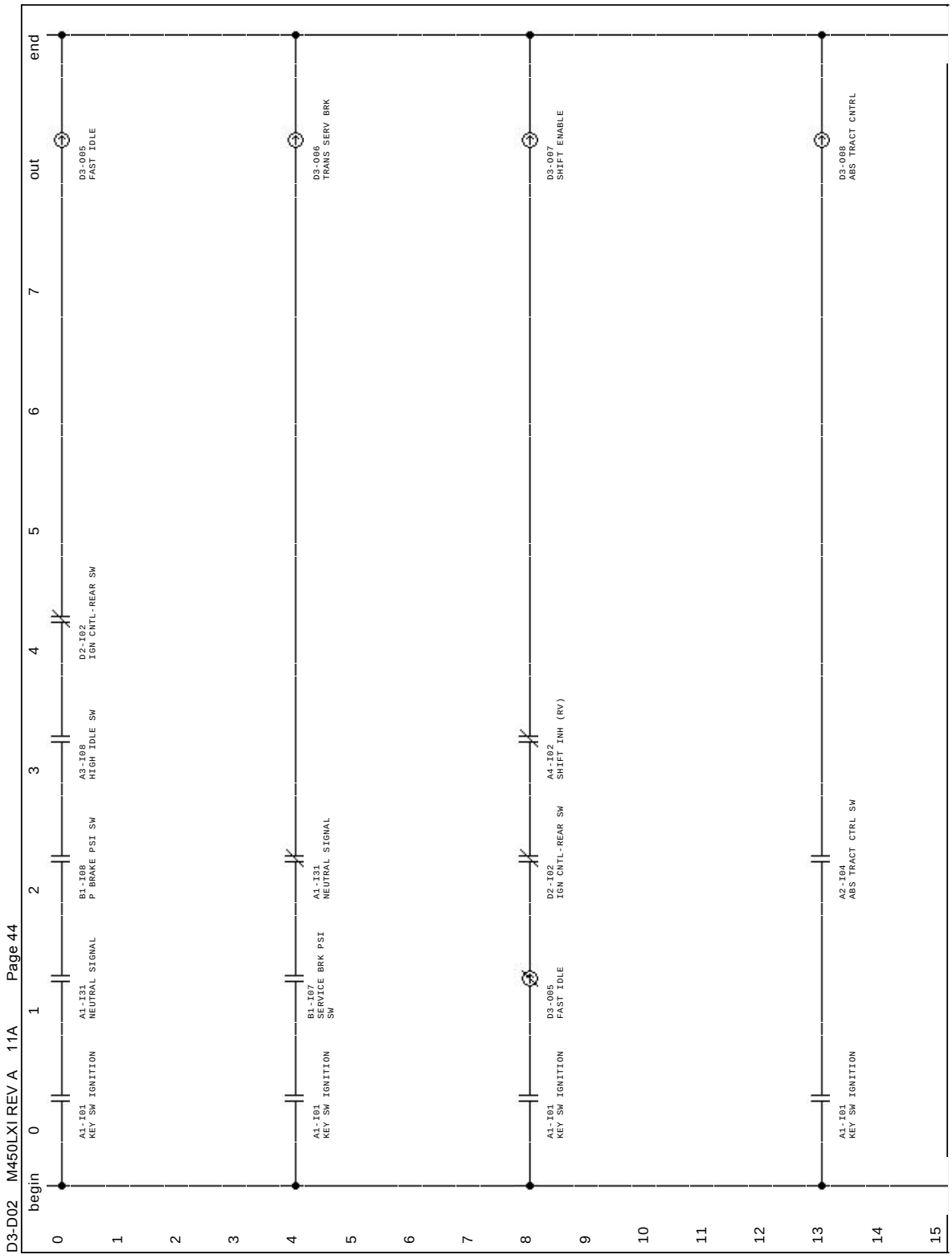

D1-D01 M450LXI REV A 11A Page 39
begin
0
1
2
3
4
5
6
7
out
end
A1-I02
HEADLIGHT SW ON
POSITION
A1-I03
HEADLIGHTS PARK
POSITION
D1-001
TAIL LIGHTS
B1-I07
SERVICE BRK PSI
SW
D1-002
STOP LAMPS
A1-I01
KEY SW IGNITION
B1-I02
LFT TURN SW
B1-F01
FLASH FLAG
D1-003
R/S TURN SIGNAL
A1-I10
HAZARD SW
A1-I01
KEY SW IGNITION
B1-I03
RT TURN SW
B1-F01
FLASH FLAG
D1-004
C/S TURN SIGNAL
A1-I10
HAZARD SW
A1-I01
KEY SW IGNITION
D1-005
AIR DRYER
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15

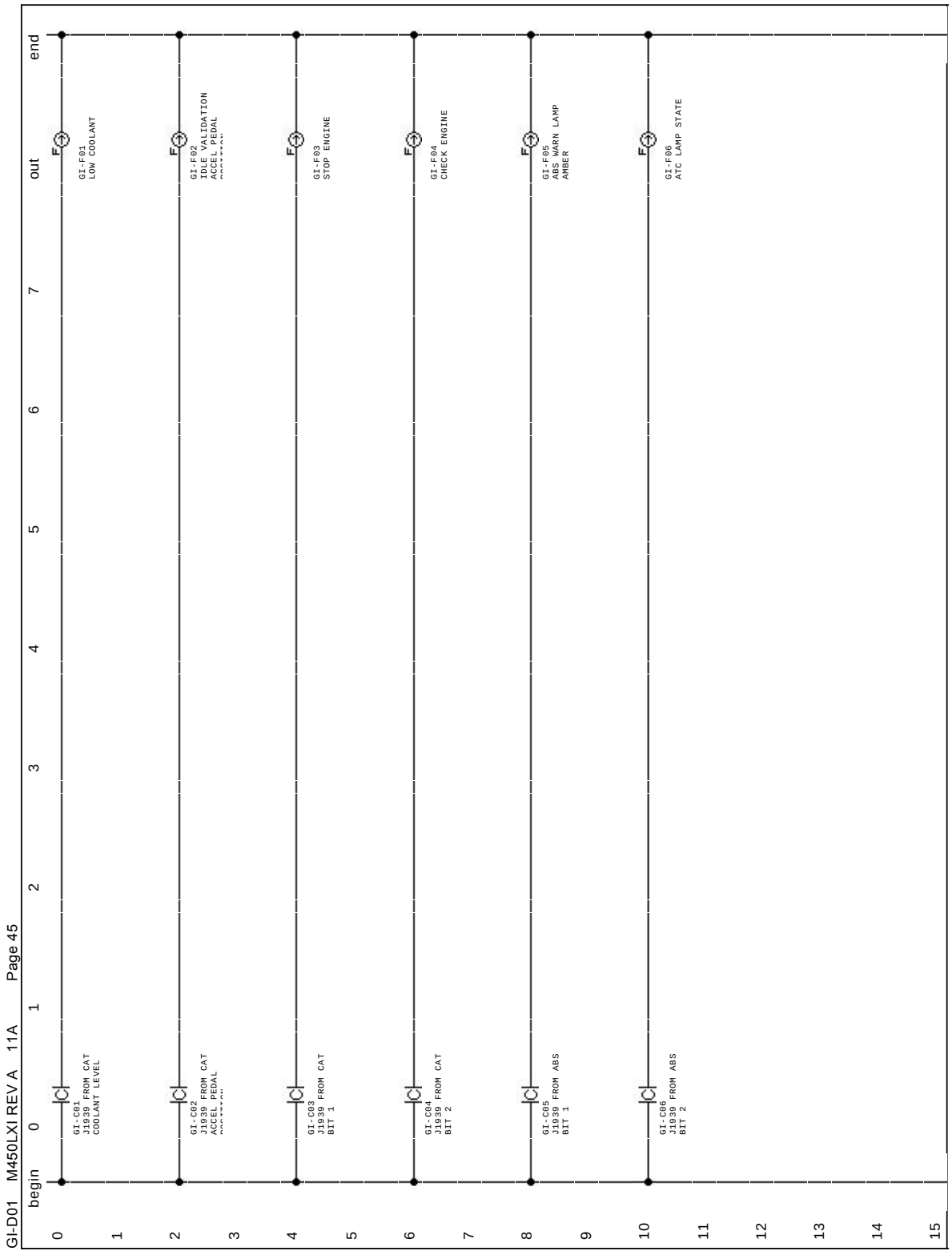

D1-D02 M450LXI REV A 11A Page 40
begin
out
end
A1-I01
KEY SW IGNITION
D3-I07
REVERSE SIGNAL
(113V4)
D1-O07
BACKUP
ALARM/LIGHTS

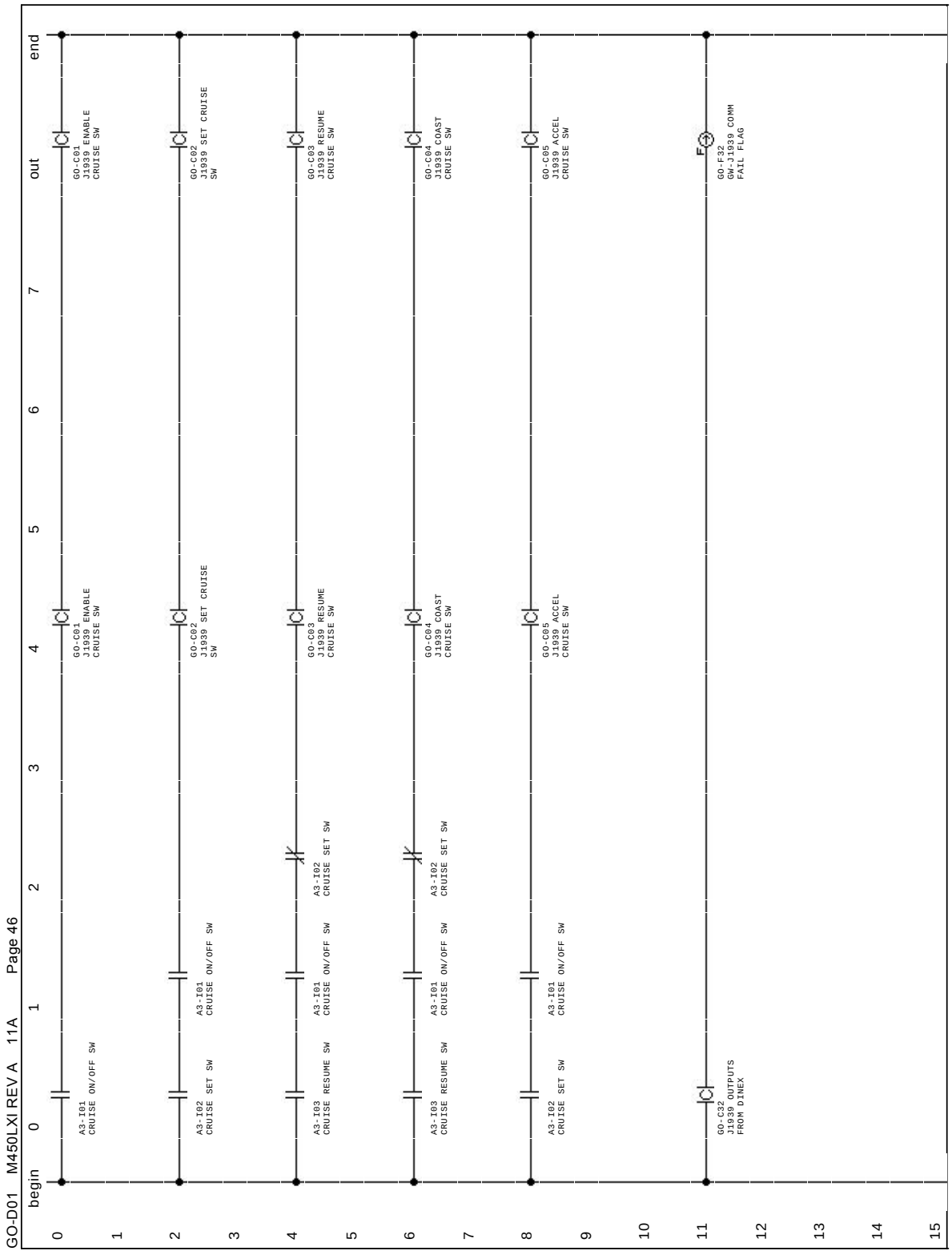

D2-D01 M450LXI REV A 11A Page 41
begin
out
end
A1-I01
KEY SW IGNITION
D2-001
FUEL HEATER
A1-I04
KEY SWITCH -
START POSITION
D2-I01
IGN CNTL-FWD SW
D2-I04
ENGINE DOOR OPEN
A1-I31
NEUTRAL SIGNAL
D2-003
STARTER SOLENOID
TON
D2-T01
15 SEC TIMER
D2-I02
IGN CNTL-REAR SW
D2-I03
REAR START SW
B1-I08
P BRAKE PSI SW
D1-I04
HOT HYD FLUID FAN
D2-005
HYDRAULIC FAN RLY

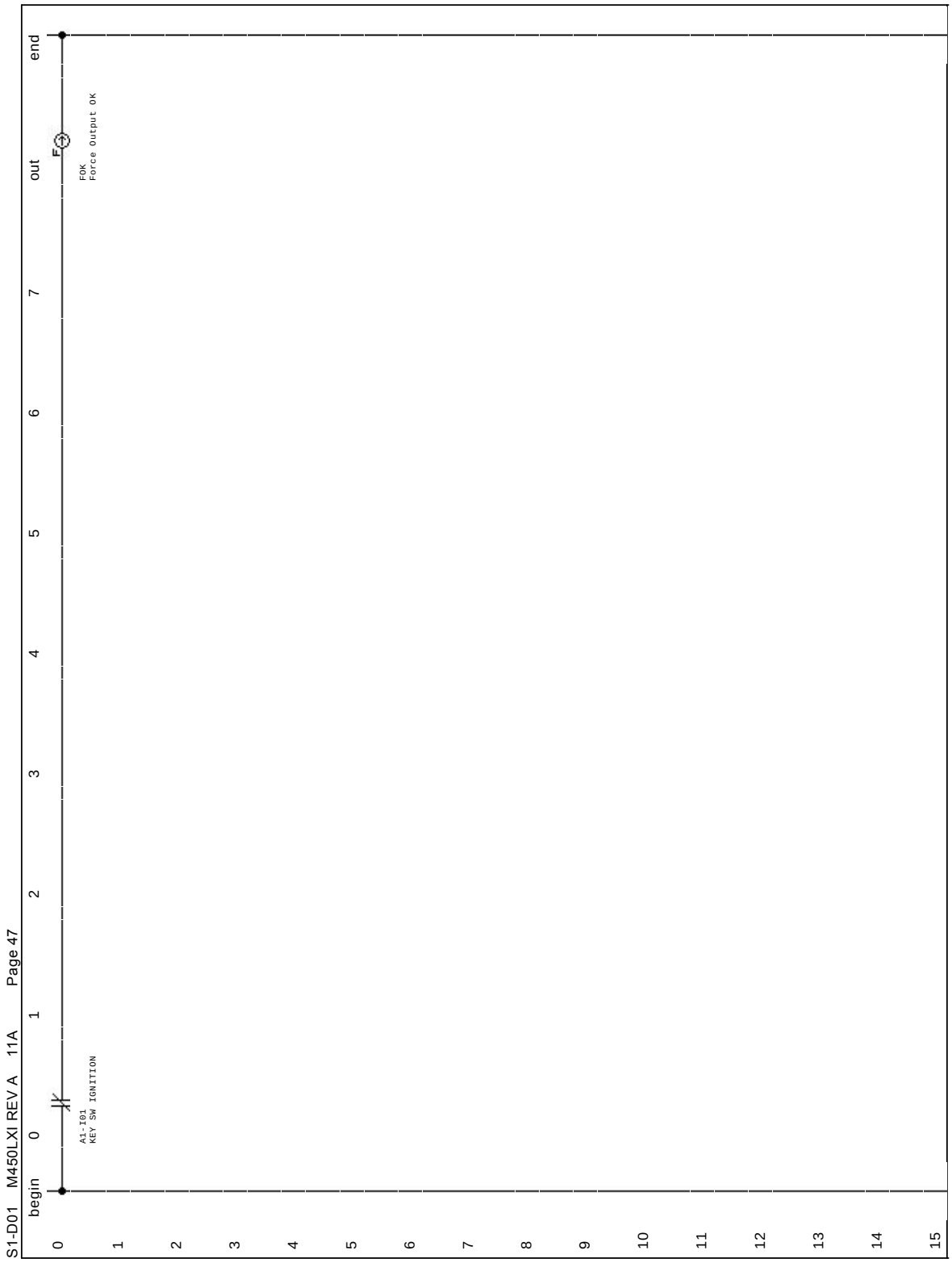

D2-D02 M450LXI REV A 11A Page 42
begin
out
end
D2-007
REAR IGN POWER
D2-008
ALTERNATOR
EXCITER/FAN POWER
A1-I01
KEY SW IGNITION
D2-I01
IGN CNTL-FWD SW
D2-I02
IGN CNTL-REAR SW
B1-I08
P BRAKE PSI SW
D0F
D2-T02
ALT EXCITER 1 SEC
A1-I01
KEY SW IGNITION


D3-D01 M450LXI REV A 11A Page 43
begin
out
end
D3-O01 THROTTLE INTERLOCK
D3-O02 ENG SERV BRAKE
D3-O03 ENG BRK LO/HI
D3-O04 ENG BRAKE MED/HI
D3-O05 FAST IDLE
D2-I02 IGN CNTL-REAR SW
A1-I01 KEY SW IGNITION
B1-I07 SERVICE BRK PSI SW
A2-I03 CRUISE CONTROL CANCEL
A3-I04 ENGINE BRAKE ENABLE SW
A3-I05 ENGINE BRAKE LOW SW
A3-I06 ENGINE BRAKE MED SW
A3-I07 ENG BRAKE HI


D3-D02 M450LXI REV A 11A Page 44
begin
0
1
2
3
4
5
6
7
out
end
A1-I01
KEY SW IGNITION
A1-I31
NEUTRAL SIGNAL
B1-I08
P BRAKE PSI SW
A3-I08
HIGH IDLE SW
D2-I02
IGN CNTL-REAR SW
D3-O05
FAST IDLE
A1-I01
KEY SW IGNITION
B1-I07
SERVICE BRK PSI SW
A1-I31
NEUTRAL SIGNAL
D3-O06
TRANS SERV BRK
A1-I01
KEY SW IGNITION
D3-O05
FAST IDLE
D2-I02
IGN CNTL-REAR SW
A4-I02
SHIFT INH (RV)
D3-O07
SHIFT ENABLE
A1-I01
KEY SW IGNITION
A2-I04
ABS TRACT CTRL SW
D3-O08
ABS TRACT CNTRL
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15


GI-D01 M450LXI REV A 11A Page 45
begin
0
1
2
3
4
5
6
7
out
end
GI-C01
J1939 FROM CAT
COOLANT LEVEL
GI-F01
LOW COOLANT
GI-C02
J1939 FROM CAT
ACCEL PEDAL
GI-F02
IDLE VALIDATION
ACCEL PEDAL
GI-C03
J1939 FROM CAT
BIT 1
GI-F03
STOP ENGINE
GI-C04
J1939 FROM CAT
BIT 2
GI-F04
CHECK ENGINE
GI-C05
J1939 FROM ABS
BIT 1
GI-F05
ABS WARN LAMP
AMBER
GI-C06
J1939 FROM ABS
BIT 2
GI-F06
ATC LAMP STATE
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15


GO-D01 M450LXI REV A 11A Page 46
begin
0
1
2
3
4
5
6
7
out
end
A3-I01
CRUISE ON/OFF SW
A3-I02
CRUISE SET SW
A3-I03
CRUISE RESUME SW
A2-I01
CRUISE ON/OFF SW
A3-I01
CRUISE ON/OFF SW
A3-I02
CRUISE SET SW
A3-I03
CRUISE RESUME SW
A2-I01
CRUISE ON/OFF SW
A3-I02
CRUISE SET SW
A3-I01
CRUISE ON/OFF SW
GO-C32
J1939 OUTPUTS
FROM DINEX
GO-C01
J1939 ENABLE
CRUISE SW
GO-C02
J1939 SET CRUISE
SW
GO-C03
J1939 RESUME
CRUISE SW
GO-C04
J1939 COAST
CRUISE SW
GO-C05
J1939 ACCEL
CRUISE SW
GO-F32
GW-J1939 COMM
FAIL FLAG
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15


S1-D01 M450LXI REV A 11A Page 47
begin
out
end
A1-I01
KEY SW IGNITION
FOK
Force Output OK

	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
V0	N/A	CLEARANCE LTS SW	N/A	N/A	N/A	N/A	HAZARD SW	N/A	N/A	SPARE	SPARE	SPARE	KEY SWITCH - START POSITION	HEADLIGHTS PARK POSITION	HEADLIGHT SW ON POSITION	KEY SW IGNITION
	A1-I16	A1-I15	A1-I14	A1-I13	A1-I12	A1-I11	A1-I10	A1-I09	A1-I08	A1-I07	A1-I06	A1-I05	A1-I04	A1-I03	A1-I02	A1-I01
V1	N/A	NEUTRAL SIGNAL	N/A		12V DISCONNECT SHUTDOWN			SPARE	ACCESSORY (RV)	HORN SW	SMRT WHL HORN REQ	N/A	N/A	N/A	N/A	N/A
	A1-I32	A1-I31	A1-I30	A1-I29	A1-I28	A1-I27	A1-I26	A1-I25	A1-I24	A1-I23	A1-I22	A1-I21	A1-I20	A1-I19	A1-I18	A1-I17
V2	ID=79 COMM FAIL	ID=78 COMM FAIL	ID=77 COMM FAIL	ID=76 COMM FAIL	ID=75 COMM FAIL	ID=74 COMM FAIL	ID=73 COMM FAIL	ID=72 COMM FAIL	ID=71 COMM FAIL	ID=70 COMM FAIL	ID=69 COMM FAIL	ID=68 COMM FAIL	ID=67 COMM FAIL	ID=66 COMM FAIL	ID=65 COMM FAIL	ID=64 COMM FAIL
	GO		A1				B2	B1	D3	D2	D1			A4	A3	A2
V3																
V4	RES. RT MODE	RES. RT MODE	RES. RT MODE	RES. RT MODE	ID Address	ID Address	ID Address	ID Address								
V5																
V6																
V7																
T0	ABS WARN LAMP AMBER	FLASH FLAG	RT TURN LTS & MIRROR	LFT TURN LTS & MIRROR	FAST IDLE	STARTER SOLENOID	FLASH CODE FLAG	BIST CHIRP FLAG	SLOW BIST FLAG	BIST COMBO FLAG	IDLE VALIDATION ACCEL PEDAL POSITION	LOW COOLANT	ABS NO DATA J1939	CAT NO DATA J1939 FROM ENGINE	GW-J1939 COMM FAIL FLAG	ATS OK TO RUN FLAG
	GI-F05	B1-F01	B1-O04	B1-O03	D3-O05	D2-O03	A1-F05	A1-F04	A1-F03	A1-F02	GI-F02	GI-F01	A1-F07	A1-F06	GO-F32	A1-F01
T1																ATC LAMP STATE

M450LXI REV A ADJ PEDAL UPGRADE By: Paul Boulet Printed: 2/15/2008 Page 48

	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
																GI-F06
T2	ID=95 COMM FAIL	ID=94 COMM FAIL	ID=93 COMM FAIL	ID=92 COMM FAIL	ID=91 COMM FAIL	ID=90 COMM FAIL	ID=89 COMM FAIL	ID=88 COMM FAIL	ID=87 COMM FAIL	ID=86 COMM FAIL	ID=85 COMM FAIL	ID=84 COMM FAIL	ID=83 COMM FAIL	ID=82 COMM FAIL	ID=81 COMM FAIL	ID=80 COMM FAIL
V10	HIGH IDLE SW	ENG BRAKE HI	ENGINE BRAKE MED SW	ENGINE BRAKE LOW SW	ENGINE BRAKE ENABLE SW	CRUISE RESUME SW	CRUISE SET SW	CRUISE ON/OFF SW	HEADLAMP FLASH (SIGNAL FROM SMART	N/A	N/A	MIRROR HEAT SW	ABS TRACT CTRL SW	CRUISE CONTROL CANCEL (FROM SMART	HORN SELECT (AIR) SW	HORN SELECT SW (ELECTRIC)
	A3-I08	A3-I07	A3-I06	A3-I05	A3-I04	A3-I03	A3-I02	A3-I01	A2-I08	A2-I07	A2-I06	A2-I05	A2-I04	A2-I03	A2-I02	A2-I01
V11	P BRAKE PSI SW	SERVICE BRK PSI SW				RT TURN SW	LFT TURN SW	HIGH BEAM SW			N/A	N/A	MASTER RLY INPUT (RV)	N/A	SHIFT INH (RV)	N/A
	B1-I08	B1-I07	B1-I06	B1-I05	B1-I04	B1-I03	B1-I02	B1-I01	A4-I08	A4-I07	A4-I06	A4-I05	A4-I04	A4-I03	A4-I02	A4-I01
V12					HOT HYD FLUID FAN	GEN RUN SIG ALT 2	GEN RUN SIGNAL ALT 1	TEMP DETECTORS			DASH FRT DOOR LOCK SW	FOG LT SW				
	D1-I08	D1-I07	D1-I06	D1-I05	D1-I04	D1-I03	D1-I02	D1-I01	B2-I08	B2-I07	B2-I06	B2-I05	B2-I04	B2-I03	B2-I02	B2-I01
V13	HOT RANS SIGNAL (105V19)	REVERSE SIGNAL (113V4)	CHECK TRANS SIGNAL (115S31)					THREE MPH SPEED SIGNAL (167V5)	STOP ENGINE TT	CHECK ENGINE TT	WATER IN FUEL	N/A	ENGINE DOOR OPEN	REAR START SW	IGN CNTL-REAR SW	IGN CNTL-FWD SW
	D3-I08	D3-I07	D3-I06	D3-I05	D3-I04	D3-I03	D3-I02	D3-I01	D2-I08	D2-I07	D2-I06	D2-I05	D2-I04	D2-I03	D2-I02	D2-I01
V14																
V15																
V16																
V17	System 1st Scan	Force Output OK														
	FSCAN	FOK														

	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
V20																
V21																
V22																
V23																
V24																
V25																
V26																
V27																

Dometic® Duo-Therm®

RECORD THIS UNIT INFORMATION FOR FUTURE REFERENCE:
Model Number_____
Serial Number_____
Date Purchased_____

MODEL
620515, 620525, 620526
Roof-Top Air Conditioner
630515, 630516
Roof Top Heat Pump

used with one of following:

3105007 Return Air Cover
3105935 Quick Cool Return Air Cover
3308120 Genesis Air Filtration System
and
3109228.001 Comfort Control Center™

THIS UNIT IS DESIGNED FOR OEM INSTALLATION
ALL INITIAL INSTALLATIONS MUST BE APPROVED BY THE SALES DEPT.

USA
SERVICE OFFICE
Dometic Corporation
2320 Industrial Parkway
Elkhart, IN 46515
574-294-2511

CANADA
Dometic Distribution
866 Langs Drive
Cambridge, Ontario
CANADA N3H 2N7
519-653-4390

For Service Center Assistance Call:
800-544-4881

C SA® US

⚠ WARNING

This manual must be read and understood before installation, adjustment, service, or maintenance is performed. This unit must be installed by a qualified service technician. Modification of this product can be extremely hazardous and could result in personal injury or property damage.

⚠ AVERTISSEMENT

Lire et comprendre ce manuel avant de procéder à l'installation, à des réglages, de l'entretien ou des réparations. L'installation de cet appareil doit être effectuée par un réparateur qualifié. Toute modification de cet appareil peut être extrêmement dangereuse et entraîner des blessures ou dommages matériels.

INSTALLATION INSTRUCTIONS

Models

620515.331	620526.336
620515.336	630515.331
620525.331	630515.336
620525.336	630516.331
620526.331	630516.336

REVISION:
Form No. 3309083.016 2/05
(Replaces 3309083.008)
(French 3309084.014)

LaGrange, IN 46761

Important: These Instructions must stay with unit. Owner read carefully.

SAFETY INSTRUCTIONS

This manual has safety information and instructions to help users eliminate or reduce the risk of accidents and injuries.

RECOGNIZE SAFETY INFORMATION

This is the safety-alert symbol. When you see this symbol in this manual, be alert to the potential for personal injury.

Follow recommended precautions and safe operating instructions.

UNDERSTAND SIGNAL WORDS

A signal word , **WARNING** OR **CAUTION** is used with the safety-alert symbol. They give the level of risk for potential injury.

⚠ WARNING indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury.

⚠ CAUTION indicates a potentially hazardous situation which, if not avoided may result in minor or moderate injury.

CAUTION used without the safety alert symbol indicates, a potentially hazardous situation which, if not avoided may result in property damage.

Read and follow all safety information and instructions.

GENERAL INFORMATION

A. Product features or specifications as described or illustrated are subject to change without notice.

B. This Air Conditioner Is Designed For:

1. Installation on a recreational vehicle during the time the vehicle is manufactured.
2. Mounting on the roof of a recreational vehicle.
3. Roof construction with rafters/joists on minimum of 16 inch centers.
4. Minimum of 2.00 inches and maximum of 5.50 inches distance between roof to ceiling of recreational vehicle. Alternate installation methods will allow for roofs more than 5.50 inches thick.

C. The ability of the air conditioner to maintain the desired inside temperature depends on the heat gain of the RV. Some preventative measures taken by the occupants of the RV can reduce the heat gain and improve the performance of the air conditioner. During extremely high outdoor temperatures, the heat gain of the vehicle may be reduced by:

1. Parking the RV in a shaded area
2. Using window shades (blinds and/or curtains)
3. Keeping windows and doors shut or minimizing us age
4. Avoiding the use of heat producing appliances

Operation on High Fan/Cooling mode will give optimum or maximum efficiency in high humidity or high outside temperatures.

Starting the air conditioner early in the morning and giving it a "head start" on the expected high outdoor ambient will greatly improve its ability to maintain the desired indoor temperature.

For a more permanent solution to high heat gain, accessories like A&E outdoor patio and window awnings will reduce heat gain by removing the direct sun. They also add a nice area to enjoy company during the cool of the evening.

D. Condensation

Note: The manufacturer of this air conditioner will not be responsible for damage caused by condensed moisture on ceilings or other surfaces. Air contains moisture and this moisture tends to condense on cold surfaces. When air enters the RV, condensed moisture may appear on the ceiling, windows, metal parts, etc. The air conditioner removes this moisture from the air during normal operation. Keeping doors and windows closed when this air conditioner is in operation will minimize condensed moisture on cold surfaces.

SPECIFICATIONS

Model No.	Nominal Capacity (BTU/HR) Cooling	Electrical Rating Amps	Heater Watts	Compressor Rated Load Amps	Compressor Locked Rotor Amps	Fan Motor Rated Load Amps	Fan Motor Locked Rotor Amps	SCFM-High Speed Max./Min. W.C.	Total Static Max./Min.	Refrigerant R-22 (Oz.)	Minimum Wire Size*	AC Circuit Protection ** User Supplied	Installed Weight (Pounds)	Minimun Generator Size** 1Unit/2Units
620515.331	13,500	120VAC 60Hz. 1 Phase	1530	12.4	60.0	3.5	10.0	335/250	.012/0.65	16.5	12 AWG Copper Up To 24'	20 Amp	95	3.5 KW/5.0 KW
620515.336	13,500		1530	12.4	60.0	3.5	10.0	335/250	.012/0.65	16.5		20 Amp	95	3.5 KW/5.0 KW
620525.331	13,500		1530	12.4	60.0	3.5	10.0	335/250	.012/0.65	16.5		20 Amp	95	3.5 KW/5.0 KW
620525.336	13,500			12.4	60.0	3.5	10.0	335/250	.012/0.65	16.5		20 Amp	95	3.5 KW/5.0 KW
620526.331	15,000			12.0	64.0	3.3	8.2	380/250	.012/0.65	20.0		20 Amp	95	3.5 KW/5.0 KW
620526.336	15,000			12.0	64.0	3.3	8.2	380/250	.012/0.65	20.0		20 Amp	95	3.5 KW/5.0 KW
630515.331	13,500			12.4	60.0	3.5	10.0	335/250	.012/0.65	23.5		20 Amp	95	3.5 KW/5.0 KW
630515.336	13,500			12.4	60.0	3.5	10.0	335/250	.012/0.65	23.5		20 Amp	95	3.5 KW/5.0 KW
630516.331	15,000			12.0	64.0	3.3	8.5	335/250	.012/0.65	20.0		20 Amp	95	3.5 KW/5.0 KW
630516.336	15,000			12.0	64.0	3.3	8.5	335/250	.012/0.65	20.0		20 Amp	95	3.5 KW/5.0 KW

* For wire length over 24 ft., consult the National Electric Code for proper sizing.

** Dometic Corporation gives **GENERAL** guidelines for generator requirements. These guidelines come from experiences people have had in actual applications. When sizing the generator, the total power usage of your recreational vehicle must be considered. Keep in mind generators lose power at high altitudes and from lack of maintenance.

*** CIRCUIT PROTECTION: Time Delay Fuse or HACR Circuit Breakers Required.

INSTALLATION INSTRUCTIONS

A. Precautions

⚠ WARNING

Improper installation may damage equipment, could endanger life, cause serious injury and/or property damage.

1. Read Installation and Operating Instructions carefully before attempting to start your air conditioner installation.
2. Dometic Corporation will not be liable for any damages or injury incurred due to failure in following these instructions.
3. Installation must comply with the National Electrical Code ANSI/NFPA-70 and CSA Standard C22.1 (latest edition and any State or Local Codes or regulations.
4. **DO NOT** add any devices or accessories to this air conditioner except those specifically authorized by Dometic.
5. This equipment must be serviced by qualified personnel and some states require these people to be licensed.

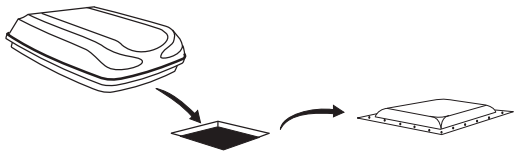
B. Choosing Proper Location For The Air Conditioner

This air conditioner is specifically designed for installation on the roof of a recreational vehicle (RV). When determining your cooling requirements, the following should be considered:

- Size of RV;
- Window area (increases heat gain);
- Amount of insulation in walls and roof;
- Geographical location where the RV will be used;
- Personal comfort level required.

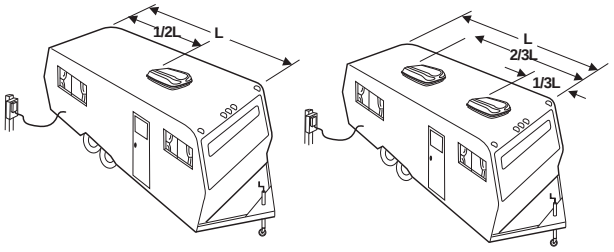
1. Normal Location-The air conditioner is designed to fit over an existing roof vent opening.

FIG. 1



2. Other Locations-When no roof vent is available or another location is desired, the following is recommended:
   a. For one unit installation: The air conditioner should be mounted slightly forward of center (front to back) and centered from side to side.
   b. For two unit installations: Install one Air Conditioner 1/3 and one Air Conditioner 2/3's from front of RV and centered from side to side.

FIG. 2



It is preferred that the air conditioner be installed on a relatively **flat and level** roof section measured with the RV parked on a level surface.

Note: A 8° slant to **either** side, or front to back, is acceptable for all units.

3. After Location Has Been Selected:
   a. Check for obstructions in the area where air conditioner will be installed. See FIG. 4.
   b. The roof must be designed to support 130 pounds when the RV is in motion. Normally a 200 lb. static load design will meet this requirement.

CAUTION

It is the responsibility of the installer of this air conditioner system to ensure structural integrity of the RV roof. Never create a low spot on the roof where water will collect. Water standing around the air conditioner may leak into the interior causing damage to the product and the RV.

   c. Check inside the RV for return air kit obstructions (i.e. door openings, room dividers, curtains, ceiling fixtures, etc.) See FIG. 3 & 4.

FIG. 3

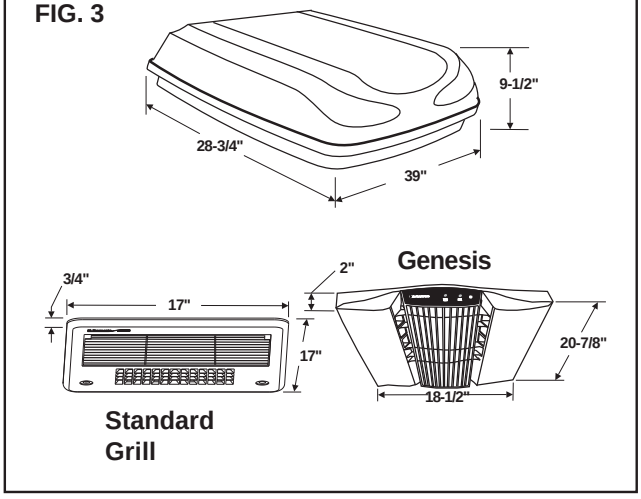
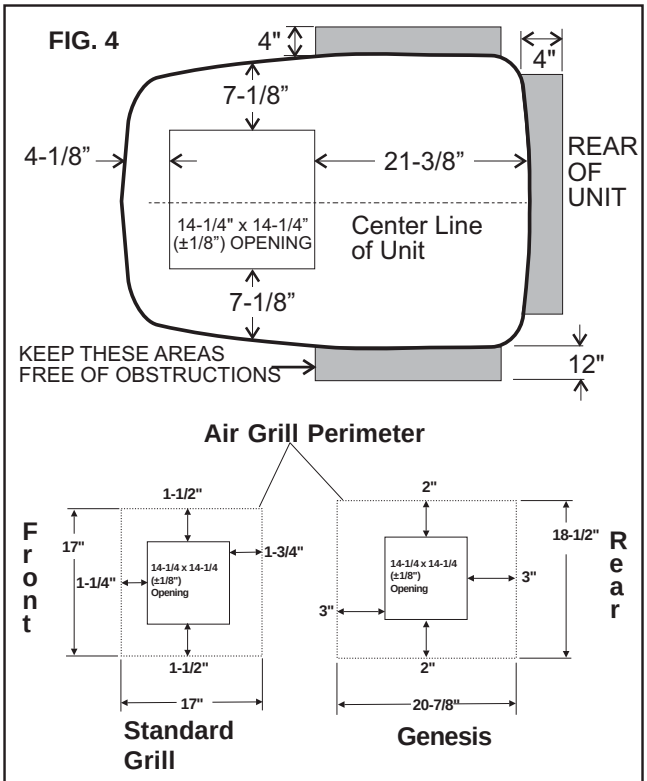


FIG. 4



C. Roof Preparation

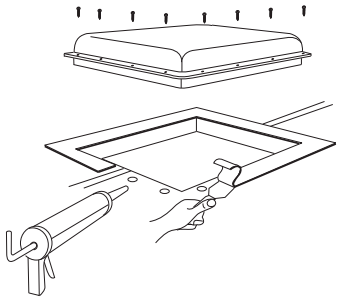
1. Opening Requirements - Before preparing the ceiling opening, the type of system options must be decided upon. Read all of the following instructions before beginning the installation.
   If a roof vent opening will not be used a 14-1/4" x 14-1/4" (±1/8") opening must be cut through the roof and ceiling of the RV. This opening must be located between the roof reinforcing members.

⚠ WARNING

There may be electrical wiring between the roof and the ceiling. Disconnect 120 volt AC power cord and the positive (+) 12 volt DC terminal at the supply battery. Failure to follow this instruction may create a shock hazard causing death or severe personal injury.

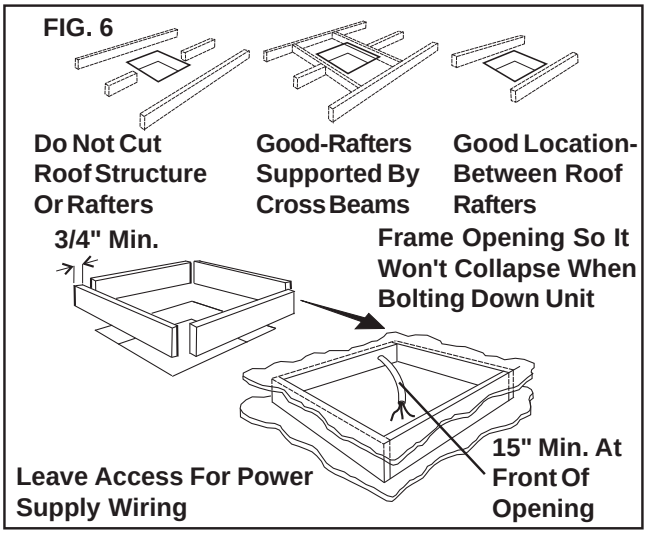
   The 14-1/4" x 14-1/4" (±1/8") opening is part of the return air system of the Air Conditioner and must be finished in accordance with NFPA Standard 501C Section 2.7.2.
2. Roof Vent Removal
   a. Unscrew and remove the roof vent.
   b. Remove all caulking compound around opening.
   c. Seal all screw holes and seams where the roof gasket is located. Use a good grade of all weather sealant. See FIG. 5.

FIG. 5



   d. If the opening exceeds 14-3/8" x 14-3/8", it will be necessary to re-size the opening to 14-1/4" x 14-1/4" (±1/8").
   e. If the opening is less than 14-1/8" x 14-1/8", it must be enlarged.
3. New Opening- (Installation Other Than Vent Opening)
   a. Mark a 14-1/4" x 14-1/4" (±1/8") square on the roof and carefully cut the opening.
   b. Using the roof opening as a guide, cut the matching hole in the ceiling.
   c. The opening created must be framed to provide adequate support and prevent air from being drawn from the roof cavity. Lumber 3/4" or more in thickness must be used. Remember to provide an entrance hole for power supplies, furnace wiring and a seven-conductor cable, 18 to 22 AWG is to be used for analog thermostat connections.

FIG. 6



CAUTION

It is the responsibility of the installer of this air conditioner system to ensure structural integrity of the RV roof. Never create a low spot on the roof where water will collect. Water standing around the air conditioner may leak into the interior causing damage to the product and the RV.

4. Air Distribution System Sizing & Design

CAUTION

It is the responsibility of the installer to insure the ductwork will not collapse or bend during and after the installation. Dometic Corporation will not be liable for roof structural or ceiling damage due to improperly insulated, sealed or collapsed ductwork.

The Installer of this air conditioner system must design the air distribution system for their particular application. Several requirements for this system **MUST** be met for the air conditioner to operate properly. These requirements are as follows:

a. The duct material must meet or exceed any agency or RVIA Standard that may be in existence at the time the RV is produced.
b. All discharge air ducts must be properly insulated to prevent condensation from forming on their surfaces or adjacent surfaces during operation of the air conditioner. This insulation must be R-7 minimum.
c. Ducts and their joints must be sealed to prevent condensation from forming on adjacent surfaces during operation of the air conditioner.
d. Return air openings must have 40 square inches minimum free area including the filter.
e. Return air to the air conditioner must be filtered to prevent dirt accumulation on air conditioner cooling surface.

5. Air Distribution System Installation
   a. Dometic Corporation recommends the basic configuration shown on page 7, for installing this air conditioner system. We have found by testing, that this configuration works best in most applications of this air conditioner system. It is the responsibility of the Installer of this system to review each RV floor plan and determine the following:
      - Duct size
      - Duct layout
      - Register size
      - Register location
      - Thermostat location

AIR DISTRIBUTION
DUCT SIZING & DESIGN CHART

Return Air Cover Model	3105007 3105935	3308120 Genesis Air Filtration System
Roof Cavity Depth	2.0 In. Min. - 5-1/2 In. Max.	2.0 In. Min. - 5-1/2 In. Max.
Duct Cross Sectional Area	21.0 Sq. In. Min.	32.0 Sq. In. Min.
Duct Size		
Depth	1-1/2 In. Min. - 2-1/2 In. Max.	2.0 In. Min. - 2-1/2 In. Max.
Width	7.0 In. Min. - 10.0 In. Max.	8.0 In. Min. - 10.0 In. Max.
Total Duct Length	15.0 Ft. Min. - 40.0 Ft. Max.	15.0 Ft. Min. - 40.0 Ft. Max.
Duct Length (short run)	1/3 Total Duct Length	1/3 Total Duct Length
Center Duct System (Only)		
Depth		2.0" In. Min. - 2.0" Max.
Width		8.0 In. Min. - 8.0 In. Max.
Total Duct Length		15.0 Ft Min. - 40 Ft. Max.
Duct Length (Short Run)		1/3 Total Length
Register Requirements		
Number Required Per Run	4 Min.	4 Min.
Register Free Air Area	14.0 Sq. In.	14.0 Sq. In.
Distance From Duct End	5.0 In. Min. - 8.0 In. Max.	5.0 In. Min. - 8.0 In. Max.
Distance From Elbow	15.0 In.	15.0 In.
Duct Static		
Blower at High Speed, Filter & Grill In Place	0.12 - 0.65 In. W.C.	0.12 - 0.65 In. W.C.

Note: Duct sizes listed are inside dimensions.

These items must be determined in conjunction with the Air Distribution System and Sizing and Design Requirements listed in the chart on page 6. Terminate the start of the duct at the back edge of the 14-1/4" x 14-1/4" (±1/8"). See FIG. 7, 7A, and 7B.

Important: Alternate configurations and methods may be used which still allow the air conditioner to operate properly; however, these alternate configurations and methods must be approved by the Dometic Corporation in writing. The following instructions are based upon the use of 3105007 Dometic Return Air Kit, 3105935 Dometic Return Air Kit or 3308120 Genesis Air Filtration System and a 3109228.001 Comfort Control Center™.

FIG. 7

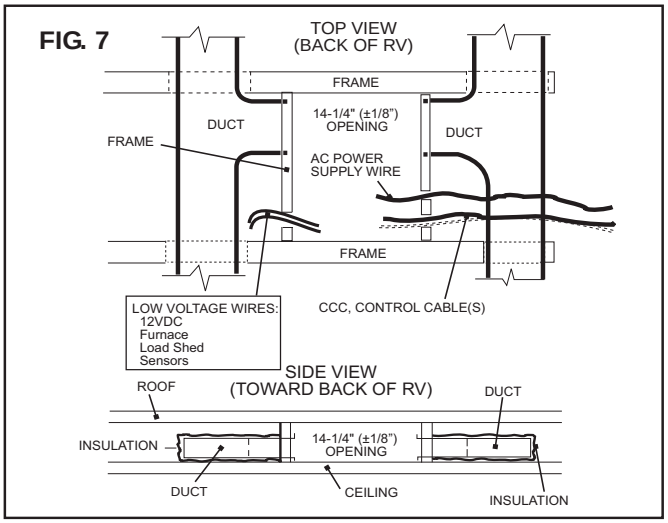


FIG. 7A Duct Size And Requirements For 3105007 And 3105935 Return Air Cover

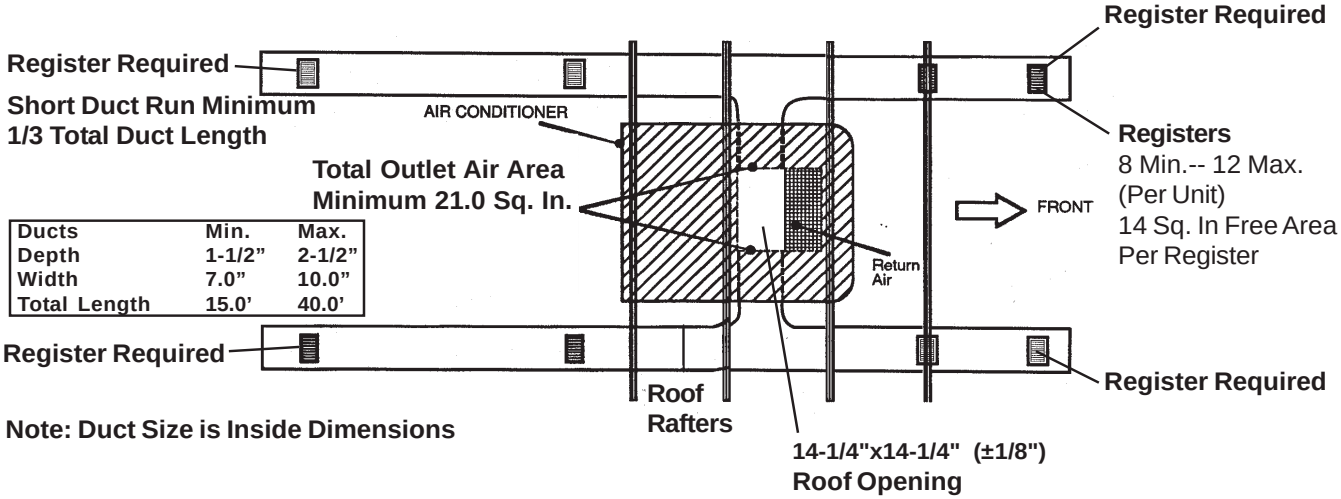
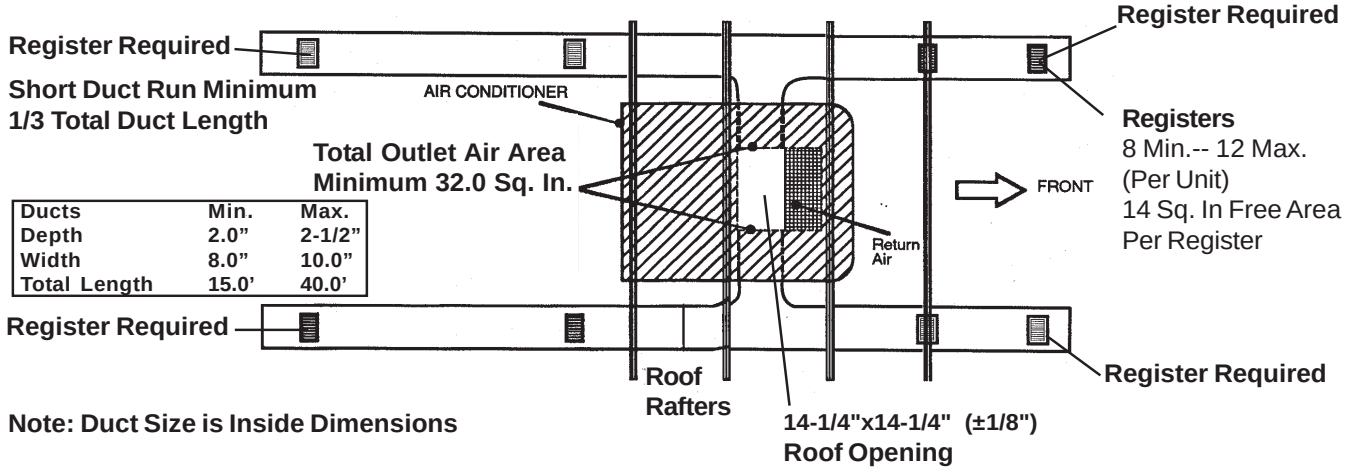


FIG. 7B Duct Size And Requirements For 3308120 Genesis Air Filtration System Kit



D. Wiring Requirements

1. 120 VAC Supply Line
   Route a copper 12 AWG, with ground, 120 VAC supply line from the time delay fuse or circuit breaker box to the roof opening.
   a. This supply line must be located in the front portion of the 14-1/4" x 14-1/4" (±1/8") opening.
   b. The power MUST be on a separate 20 Amp time delay fuse or HACR circuit breaker.
   c. Make sure that at least 15" of supply wire extends into the roof opening. This ensures and easy connection at the junction box.
   d. Wiring must comply with all National, State and Local Wiring Codes.
   e. Use a steel sleeve and a grommet or equivalent methods to protect the wire where it passes into the opening.
2. Route a dedicated 12 VDC supply line (18-22 AWG) from the RV's converter(filtered terminals) or battery to the roof opening.
   a. This supply line must be located in the front portion of the 14-1/4" x 14-1/4" (±1/8") opening.
   b. Make sure that at least 15" of supply wire extends into the roof opening.
   c. **In a multiple zone installation, this wiring is required in only one of the 14-1/4" x 14-1/4" (±1/8") openings.**
3. If a Remote Temperature Sensor is used, the connector end must be routed from the sensor location to the roof opening of the system which it will control. Make sure that at least 15" of the sensor cable extends into the roof opening. Refer to the Remote Sensor Instructions for details of the installation.
4. If a furnace is to be controlled by the system, the two furnace thermostat leads must be routed to the roof opening of the air conditioner that will control it. Make sure that at least 15" of the furnace thermostat wires extend into the roof opening.
5. If an Energy Management System (load shed feature) is to be used with the control, two wires must be routed to the roof opening of the zone to be managed. The signal required for this function is normally open relay contact. When the EMS calls for the compressor to shut off, the relay contacts should close. Make sure at least 15" of the EMS wires extend into the roof opening.
6. Route a 4-conductor control cable from the **Comfort Control Center**™ mounting position into the 14-1/4" x 14-1/4" (±1/8") roof opening. Make sure that at least 15" of the wire extends into the roof opening and 6" extend from the wall at the mounting position of the **Comfort Control Center**™. See Section E-2.
7. In the event that other Air Conditioners are installed (additional zones) an additional 4-conductor control cable must be routed to the other Air Conditioners. Make sure that at least 15" of the wire extends into the roof opening. See FIG. 27.
8. If an automatic generator start kit (AGS) will be installed, a 4-conductor control cable must be routed from the last air conditioner to location of AGS kit. Follow AGS kit instructions for installation.

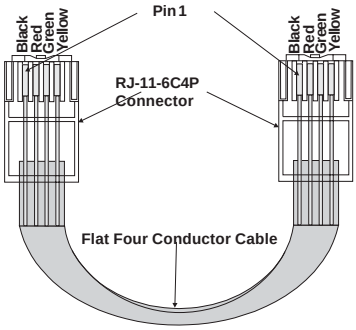
E. Dometic Comfort Control Center™ & Cable Installation

1. Location
   a. If the system is to be used **WITHOUT** a **Remote Temperature Sensor**, the proper location of the **Comfort Control Center**™ is very important to ensure that it will provide a comfortable RV temperature. Observe the following rules when selecting a location:
      - Locate the **Comfort Control Center**™ 54" above the floor.
      - Install the **Comfort Control Center**™ on a partition, not on an outside wall.
      - **NEVER** expose it to direct heat from lamps, sun or other heat producing items.
      - Avoid locations close to doors that lead outside, windows or adjoining outside walls.
      - Avoid locations close to supply registers and the air from them.
   b. If the system is to be used **WITH** a **Remote Temperature Sensor** in **ALL** zones, the **Comfort Control Center™** may be mounted anywhere that is convenient in the coach. Try to avoid hard to reach and hard to see areas.
      - Refer to the instructions provided with the **Remote Temperature Sensor** for details of installation.
   c. A 3/8" diameter hole will be needed to route the cable through the wall. See Section D-3.
2. Control Cable Installation
   A 4-conductor control cable must be routed from the roof opening to the **Comfort Control Center™**.
   a. Choose the shortest, most direct route from the 14-1/4" x 14-1/4" (±1/8") opening to the **Comfort Control Center™** location selected. Leave 6" of cable extending through the wall. See Section D-6.
   b. The control cable that should be used is a flat, 4-conductor telephone cable.
   c. The control cable must be terminated with two (2) RJ-11-6C4P telephone connectors. Refer to the crimp tool manufacture for crimping instructions. See FIG. 8A, 8B and 8C.

FIG. 8A

FIG. 8B

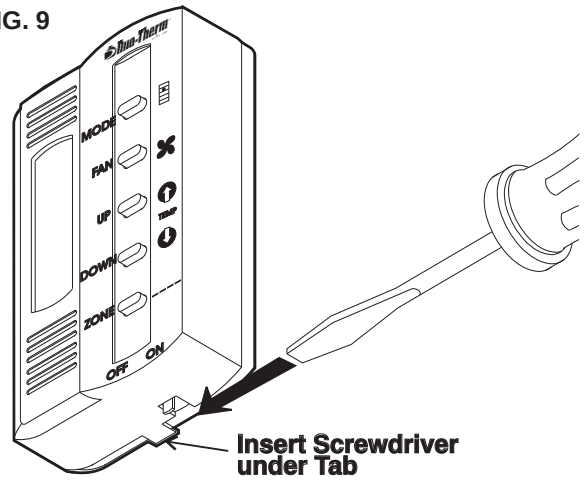
FIG. 8C



Important: RJ-11-6C4P connectors must be installed as shown in FIG. 8A, 8B & 8C.

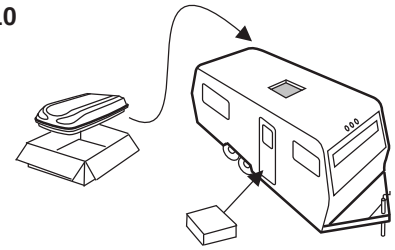
3. Comfort Control Center™ Installation
   a. Carefully remove the base plate from the **Comfort Control Center™**. This may be accomplished by inserting a small screwdriver under the tab on the bottom edge of the front cover and gently prying. See FIG. 9.
   b. Insert the control cable through the hole in the base plate and mount the plate to the wall with two (2) screws provided. Check the alignment to ensure level installation.
   c. Install the control cable RJ-11-6C4P connector into the back of the **Comfort Control Center™** and snap onto the base plate. See FIG. 9.

FIG. 9



F. Placing Air Conditioner On The Roof

FIG. 10



⚠ CAUTION

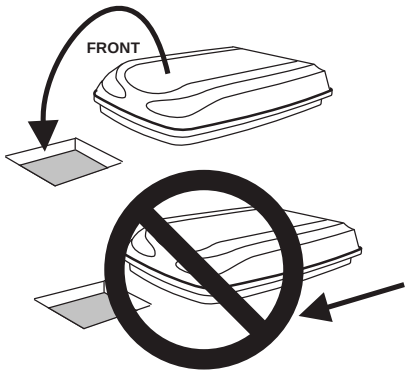
This unit weighs approximately 100 pounds. To prevent back injury, use a mechanical hoist to place Air Conditioner on roof.

1. Remove the air conditioner from the carton and discard carton. See FIG. 10.
2. Place the air conditioner on the roof.

CAUTION

Do not slide the unit. This may damage the roof gasket attached to the bottom and may create a leaky installation.

FIG. 11



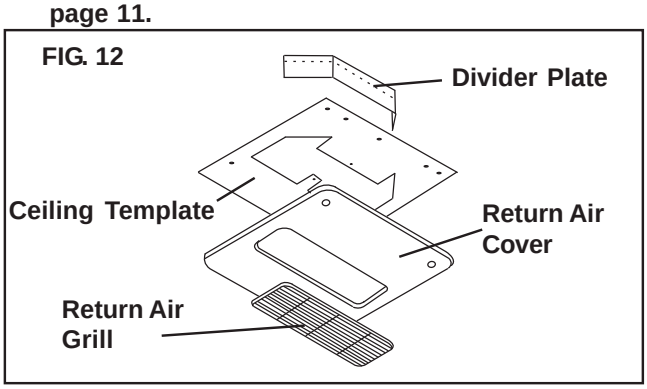
3. Lift and place the unit over the prepared opening using the gasket on the unit as a guide. See FIG. 11.
4. Place the Return Air Kit inside the RV. This box contains mounting hardware for the air conditioner and will be used inside the RV.

This completes the outside work. Minor adjustments can be done from the inside of the RV if required.

G. Installing The Air Conditioner

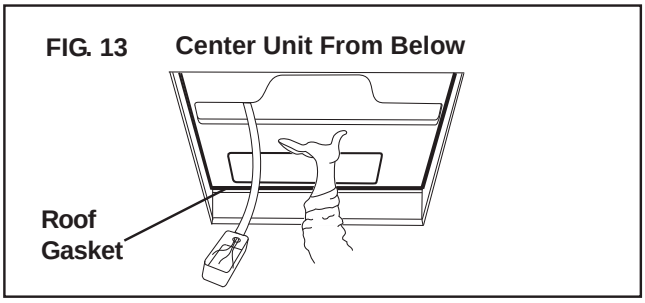
■ **Installing Unit with 3105007 or 3105935 Return Air Kit. For unit with Genesis Air Filtration System, see page 11.**

FIG. 12



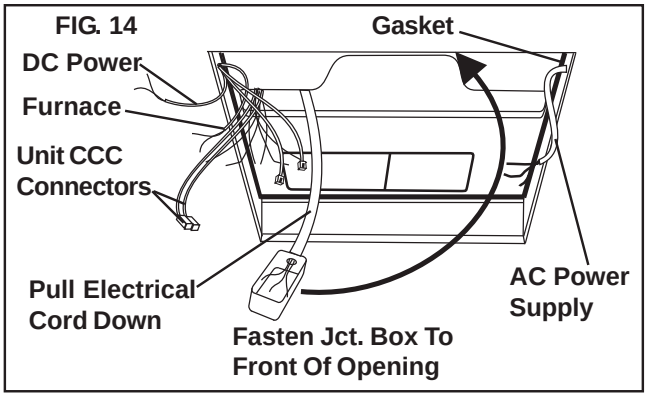
1. Installation Of Ceiling Template
   a. Check gasket alignment of the air conditioner over the roof opening and adjust if necessary. Unit may be moved from below by slightly lifting and moving. See FIG. 13.

FIG. 13 Center Unit From Below



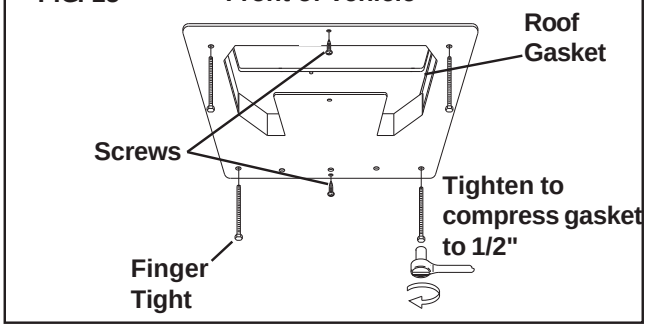
   b. Remove return air cover and ceiling template from the 3105007 or 3105935 carton.
   c. Locate the four (8" x 1/4- 20) unit mounting bolts, junction box cover and Romex connector in the 3107180 bolt kit.
   d. Pull down the unit's electrical cord and fasten the junction box with screws to the framing in the front of the 14-1/4" x 14-1/4" (±1/8") opening. See FIG. 14.

FIG. 14



   e. Install the Romex connector in the junction box.
   f. Hold the ceiling template up to the 14-1/4" x 14-1/4" (±1/8") opening. Be sure the large plate faces the rear of the RV.
   g. Start each mounting bolt through the ceiling template and up into the unit base pan by hand. Install wood screw in each end of the ceiling template. This insures a tight fit of the return air cover to ceiling. See FIG. 14. **Evenly tighten mounting bolts to compress gasket to 1/2" this will be a torque of 40 - 50 inch pounds. The bolts are self locking so over tightening is not necessary. See FIG. 15.**

FIG. 15 Front of Vehicle

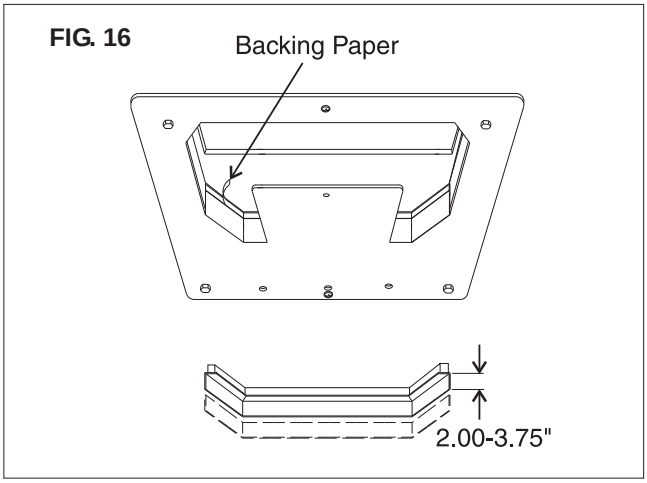


CAUTION

If bolts are left loose there may not be adequate roof seal or if over tightened, damage may occur to the air conditioner base or ceiling template. Tighten to specifications listed in this manual.

2. Installation of Divider Plate
   a. Measure the ceiling to roof thickness:
      - If distance is 2.0" - 3-3/4", remove perforated tab from divider plate.
      - If distance is 3-3/4" - 5-1/2", remove no tabs.
   b. Remove the backing paper from double sided tape located on ceiling template. See FIG. 16.

FIG. 16

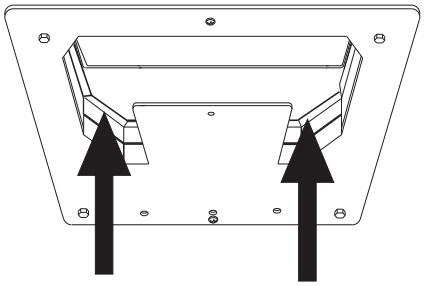


c. Place divider plate up to bottom of air conditioner base pan firmly. The foam tape on the divider plate must seal to bottom of base pan. See FIG. 17.

CAUTION

Improper installation and sealing of divider plate will cause the compressor to quick cycle on the cold control. This may result in fuse or circuit breaker opening and/or lack of cooling.

FIG. 17



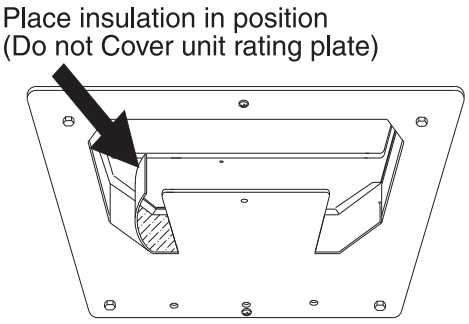
Push Divider Plate firmly onto Template

Note: The adhesive on the insulation is extremely sticky. Be sure the part is located where desired before pressing into place.

d. With slight pressure then push the divider plate against the double sided tape on the ceiling template.

e. Locate the 1/8" x 7" x 18" self -adhesive insulation supplied with the return air kit. Remove the backing paper from the insulation and carefully stick onto the ceiling template divider panel. See FIG. 18.

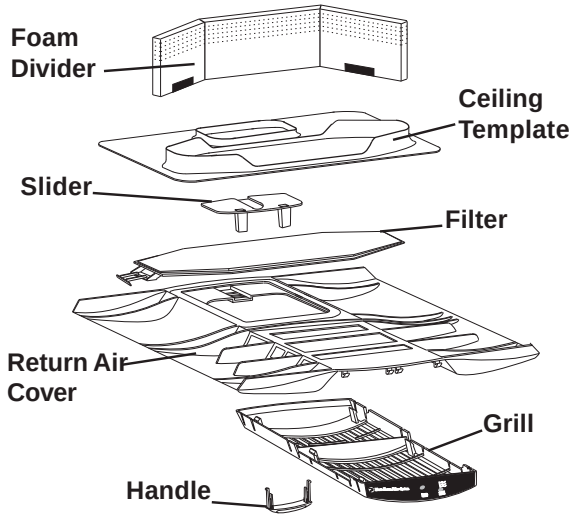
FIG. 18



- Excess width is intended to seal the divider plate to the sides of the 14-1/4" x 14-1/4" (±1/8") opening. This is to help prevent cold air discharge from circulating into the air conditioner return air opening.
- If the insulation is too high, stick excess height of insulation to the air conditioner base pan. Do not cover up unit rating plate.

■ **Installing unit with 3308120 Genesis Air Filtration System Return Air Kit. For unit with 3105007 or 3105935 Return Air Kit, see page 9.**

FIG. 19 Genesis Air Filtration System Return Air Kit



1. All Non-Center Duct Installations

Note: The Genesis Air Filtration System can be installed on units that use a center discharge duct through the 14-1/4" x 14-1/4" (±1/8") opening. Installing units with the center discharge duct go to Section 1. "Center Discharge Duct Application Installation", on page 6.

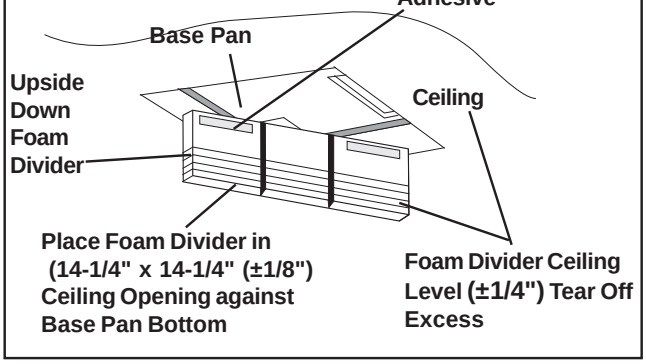
a. Check gasket alignment of the air conditioner over the roof opening and adjust if necessary. Unit may be moved from below by slightly lifting and moving. See FIG. 13.

- Remove return air cover, ceiling template, foam divider and air filter from the 3308120 carton.
- Locate the four (8" x 1/4-20) unit mounting bolts, junction box cover and Romex connector in the 3107180 bolt kit.
- Pull down the unit's electrical cord and fasten the junction box with screws to the framing in the front of the 14-1/4" x 14-1/4" (±1/8") opening. See FIG. 14.

b. Installing Foam Divider

- Locate the foam divider and insert it corner to corner in the 14-1/4" x 14-1/4" (±1/8") opening with the adhesive tape up (Do not remove paper to expose adhesive). The foam divider should be level with the ceiling (±1/4"). Tear off the excess at the pre-cut perforations in divider. See FIG. 20.

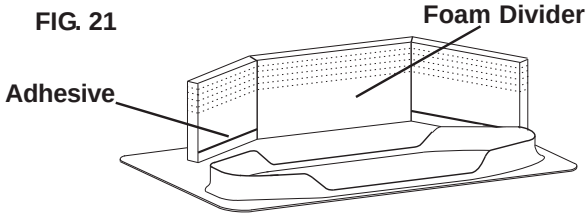
FIG. 20



c. Install Ceiling Template

- Peel the paper off of the foam divider and stick it in place on the center of the rear flange of the return air opening on the ceiling template. See FIG. 21.

FIG. 21



Peel Off Paper - Center Divider - Stick To Rear Flange On Ceiling Template

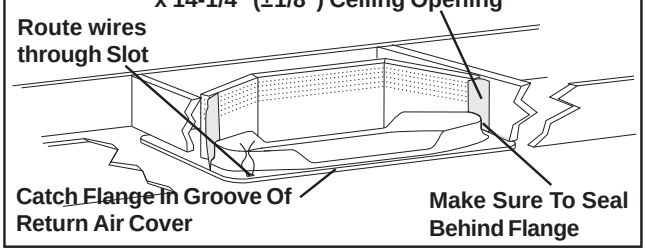
d. Start each mounting bolt through the ceiling template and up into the unit base pan by hand. **EVENLY tighten the three bolts to a torque of 40 to 50 inch pounds. This will compress the roof gasket to approximately 1/2". The bolts are self locking so over tightening is not necessary.**

CAUTION

If bolts are left loose there may not be adequate roof seal or if over tightened, damage may occur to the air conditioner base or ceiling template. Tighten to specifications listed in this manual.

e. Use Aluminum foil tape (not supplied) to seal the ends of the foam divider to the sides of the opening. Make sure the area behind the flange on the ceiling template is sealed. See FIG. 22.

FIG. 22



CAUTION

Improper installation and sealing of foam divider will cause the compressor to quick cycle on the cold control. This may result in fuse or circuit breaker opening and/or lack of cooling.

2. Center Discharge Duct Application Installation

Note: If using non-center duct installation, go to Section 1. "All Non-Center Duct Installations", on page 11.

Important: A duct adapter (not supplied) must be installed between the unit discharge and the customer installed center duct. This duct adapter must be approved by Dometic.

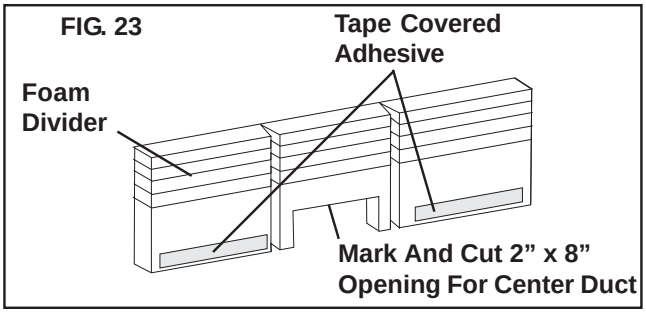
a. Check gasket alignment of the air conditioner over the roof opening and adjust if necessary. Unit may be moved from below by slightly lifting and moving. See FIG. 13.

- Remove return air cover, ceiling template, foam divider and air filter from the 3308120 carton.
- Locate the four (8" x 1/4-20) unit mounting bolts, junction box cover and Romex connector in the 3107180 bolt kit.
- Pull down the unit's electrical cord and fasten the junction box with screws to the framing in the front of the 14-1/4" x 14-1/4" (±1/8") opening. See FIG. 14.

b. Installing Foam Divider

- Cut notch in the center section of the foam divider to fit (approximately 2 x 8 inches) snugly around duct. See FIG. 23.

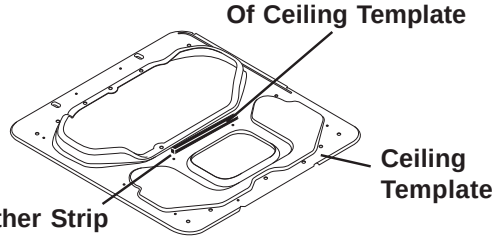
FIG. 23



- Place the foam divider in the return air opening above the center duct before installing ceiling template.

c. Install Ceiling Template
- Apply a piece of foam weather stripping (not supplied) to the upper side of ceiling template to make a seal between it and the duct. Use a soft piece of foam weather strip 1 x 3/4 x 10 inches. See FIG. 24.

FIG. 24



d. Start each mounting bolt through the ceiling template and up into the unit base pan by hand. **EVENLY tighten the three bolts to a torque of 40 to 50 inch pounds. This will compress the roof gasket to approximately 1/2". The bolts are self locking so over tightening is not necessary.**

CAUTION

If bolts are left loose there may not be adequate roof seal or if over tightened, damage may occur to the air conditioner base or ceiling template. Tighten to specifications listed in this manual.

e. Use Aluminum foil tape (not supplied) to seal the ends of the foam divider to the sides of the opening. Make sure the area behind the flange on the ceiling template is sealed. See FIG. 22.

CAUTION

Improper installation and sealing of foam divider will cause the compressor to quick cycle on the cold control. This may result in fuse or circuit breaker opening and/or lack of cooling.

f. Cut the opening in the center duct using the discharge opening in the ceiling template for a pattern. Seal the center duct to the ceiling template using foil tape, foam insulation or silicon sealant.

H. Wiring The System

Reach up into the return air opening and pull the remaining wires down.

1. Connection Of Low Voltage Wires

CAUTION

Disconnect the positive (+) 12 volt DC terminal at the supply battery. Damage to equipment could occur if the 12 volt DC is not shut off.

Note: If solar panel is installed see instructions packaged with solar panel option.

Note: If using the Genesis Air Filtration System step "b" is to be completed when installing the decorative cover.

a. Route **Remote Temperature Sensor** cable, if applicable, and attach it to the connector that matches its color in the control box.

b. Connect the previously run 12 VDC to the red and black wires protruding from the control box. (In multiple zone installations, this needs to be done at only one zone.) Connect +12 VDC to the red wire; –12 VDC to the black wire.

c. Connect the previously run furnace thermostat wires (if applicable) to the blue wires protruding from the control box. The polarity of these connections does not matter.

d. Connect the previously run Energy Management System wires (if applicable) to the yellow wires protruding from the control box. The polarity of these connections does not matter.

e. Terminate the 4-conductor control cable(s) protruding into the 14-1/4" x 14-1/4" (±1/8") roof opening. The cable(s) must be terminated with a telephone RJ-11-6C4P connector. Refer to the crimp tool manufacturer for crimping instructions.

Important: RJ-11-6C4P connectors must be installed as shown in FIG. 8A, 8B & 8C.

f. Plug the control cable(s) into the telephone jack(s) on the control box. (It does not matter which one.)

g. Locate the ambient sensor plug coming from the unit, and attach it to the connector that matches its color in the control box.

2. Connection Of 120 Volt Power Supply

⚠WARNING

Disconnect 120 volt AC. Failure to follow these instructions could create a shock hazard causing death or severe personal injury.

a. Route power supply line through Romex connector into junction box on side away from the ceiling template. Tighten connector, being careful not to pinch or short wires.
b. Connect white to white; black to black; and green to green or bare copper wire using appropriate sized twist connectors.

⚠WARNING

This product is equipped with a 3-wire (grounded) system for protection against shock hazard. Make sure that the appliance is wired into a properly grounded 120 volt AC circuit and the polarity is correct. Failure to do so could result in death, personal injury or damage to the equipment.

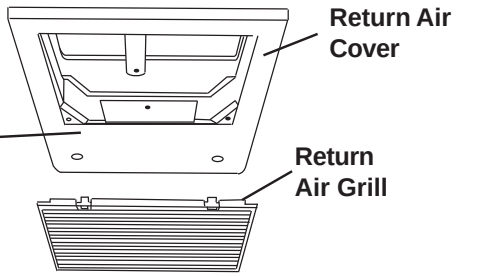
c. Tape the twist wire connectors to the supply wire to assure they don't vibrate off.
d. Push the wires into the box.
e. Install the cover onto the junction box.

I. Installing Decorative Inside Cover

■ **Installing unit with 3105007 or 3105935 Return Air Cover. For Genesis Air Filtration System Return Air Kit, see page 14.**

1. Remove the return air grill from the return air cover.
2. Place the return air cover up to the ceiling template.
3. Install cover to template with #8 x 3/8" blunt point Phillips head screws provided (6 required).
4. Reinstall filter return air grill into return air cover. Align tabs with mating notches and snap into place
5. Install two hole plugs into screw holes in back of return air cover. See FIG. 24.

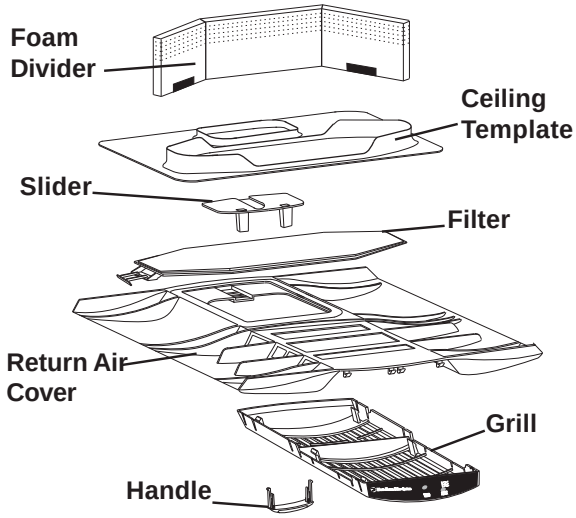
FIG. 24



6. This completes the installation of the air conditioner. We recommend that power be supplied to the air conditioner and check for proper operation. Refer to Operating Manual or Users Guide for a description of the air conditioner operation.

■ **Installing unit with 3308120 Genesis Air Filtration System Return Air Kit. For 3105007 or 3105935 Return Air Kit, see page 14.**

FIG. 25 Genesis Air Filtration System Return Air Kit



1. Install the slider in the return air cover and raise it to the ceiling template. Route the filter indicator wires from the return air cover through the template slot leaving about 3" between. Place the front of the return air cover against the ceiling and slide towards the rear. The flange on the ceiling template will catch in the groove on the return cover. Adjust the position (right to left) and install the front two screws. Start and tighten the remaining screws to hold it in place. Connect together the wires from the thermostat, unit and filter indicator.

Note: If solar panel is installed see instructions packaged with solar panel option.

a. Connect the red wire from the unit, the red wire from the filter indicator light with the red DC positive power lead. See FIG. 21.
b. Connect the black (-12V) wire from the unit, the black wire from the filter indicator light with the black (-12V) power lead.

Note: Number 10 cabinet screw can be used to replace the two front screws when the ceiling material is hard.

2. Tighten the screws holding the return air cover. Slide the filter from the right side (looking toward the RV front) over the wires. Make sure the wires are above the filter and are out of its way.
3. Place grill on return air cover and snap in place, and install decal on end over circuit board.
4. Place slide handle through slots in grill into the slide posts. Handle will fit in either direction.
5. This completes the installation of the air conditioner. We recommend that power be supplied to the air conditioner and check for proper operation. Refer to Operating Manual or User's Guide for a description of the air conditioner operation.

J. System Configuration, Reset & Check Out

Now that the system is installed, it is necessary to check all operations and then configure the electronics. Refer to the Operating manual for a description of the air conditioner operation.

1. Electronic Control Kit Configuration

   Depending on the equipment options installed by the recreational vehicle manufacturer, the appropriate dip switches will need to be switched to the "ON" position. Placing the switch in the "ON" position selects that option. See FIGS. 26, 26A & 26B.

FIG. 26

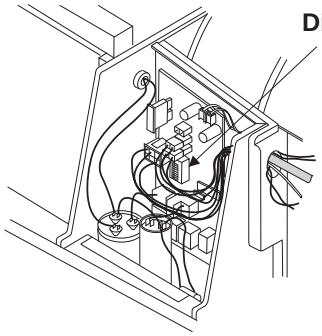
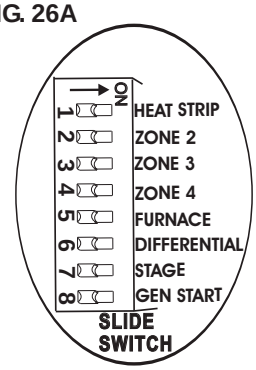
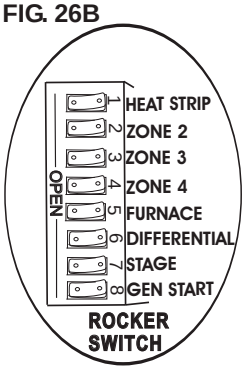


FIG. 26A



All Switches "OFF"

FIG. 26B



All Switches "OFF"

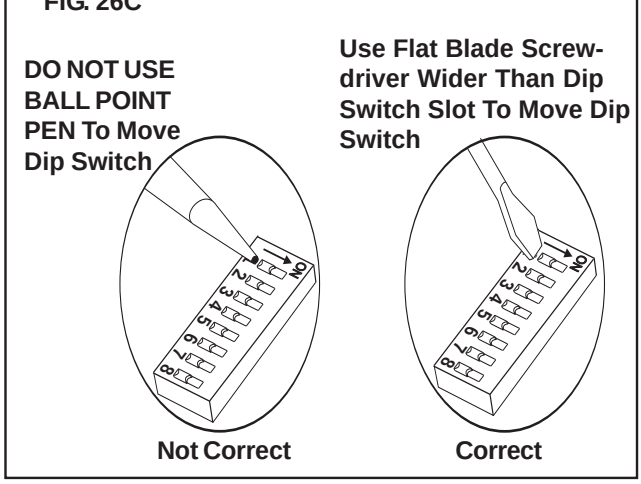
Note: Dip switches are in the "OFF" position when shipped from the factory. The dip switches are visible through the opening in the ceiling template into the control box.Dip switches can be either a rocker or sliding style of a switch. See FIGS. 26, 26A & 26B.

Important: Dip switch damage will occur if they are not set in the proper manner. A ball point pen or similar object that will slip in the switch slot, can damage the switch causing loss of connection. Use only a small flat blade screw driver (wider than the dip switch slot) to move the dip switch. See FIG. 26C.

b. Heat strip selection: Units with a heat strip, the #1 dip switch will be in the "ON" position.

c. Furnace selection - when a furnace has been connected to a zone, place the furnace dip switch "ON" for that zone.

FIG. 26C



d. Differential - differential is the temperature difference between the "ON/OFF" cycle of the thermostat in the furnace mode. The normal differential is preset in the circuit board with the dip switch set to the "OFF" position. In some situations, it may be necessary to decrease the differential. The location of the thermostat may create a condition where the normal differential will not maintain your comfort zone. If this occurs, the differential can be shortened by placing the differential dip switch to the "ON" position.

Note: Setting the differential dip switch should only be required when installation conditions are less than desirable and is not covered under the limited warranty.

e. Stage selection - stage is not used on these units. Leave in the "OFF" position.

f. Gen start selection - leave in the "OFF" position.

g. Replace the unit electrical box cover.

h. Repeat this procedure for each additional zone.

2. System Reset

   After setting the dip switches in the electronic control kit, do a system reset.

   a. Turn the ON/OFF switch to the "OFF" position.

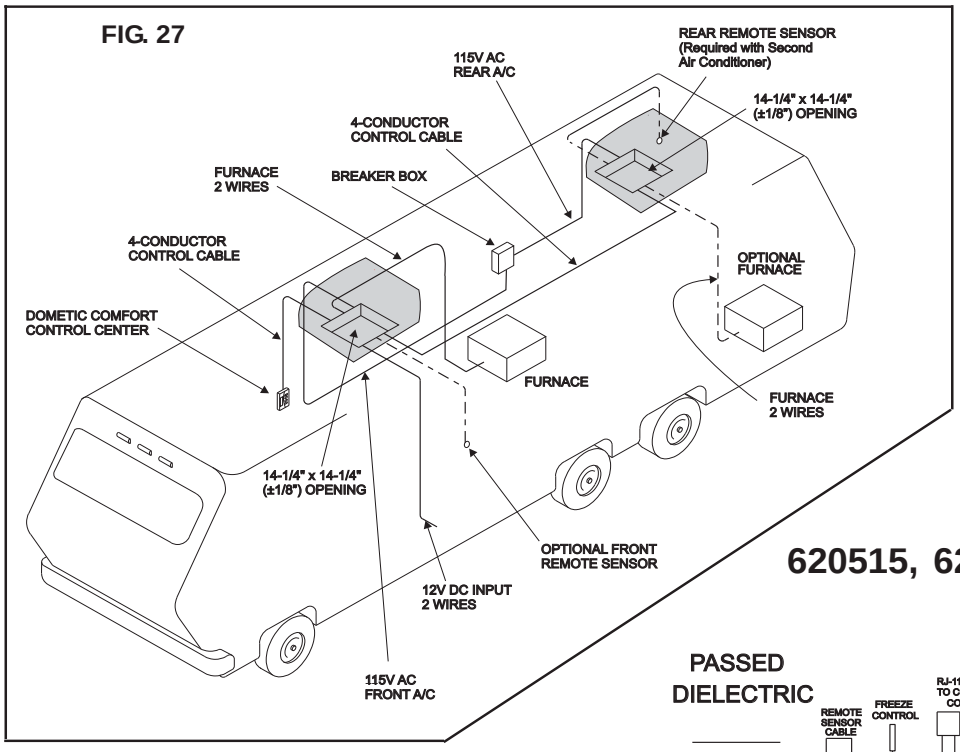
   b. Simultaneously depress and hold the MODE and ZONE push-buttons while turning the ON/OFF switch to "ON". FF should appear in LCD display until the mode and zone push-buttons are released.

   c. When a dip switch is turned on after initial configuration, a system reset will need to be done before the **Comfort Control Center™** will recognize the updated selection.

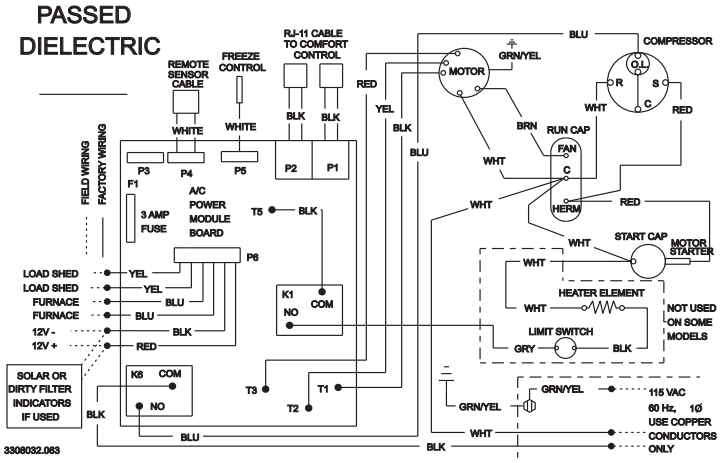
3. System Checkout

   Verify that all features of the installed system work. Check fan speeds, cooling mode, heat pump mode, furnace (if connected) and heat strip. If the features do not work, check all wiring and confirm that the correct options have been selected on the Electronic Control Box. See **Comfort Control Center™** Operating Instructions.

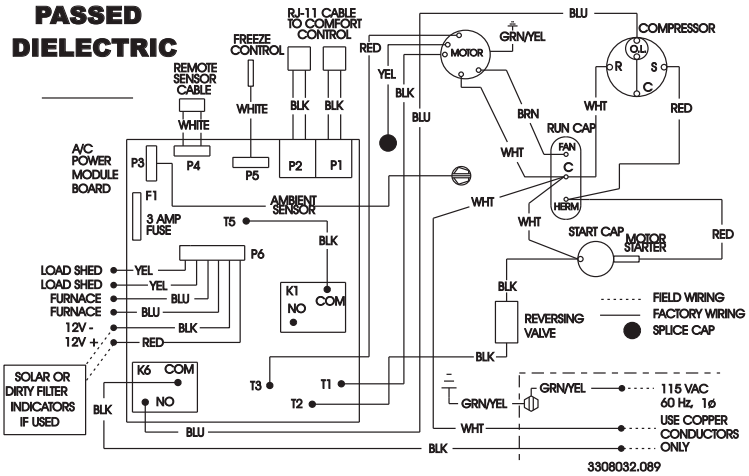
FIG. 27



620515, 620525 & 620526 WIRING DIAGRAM

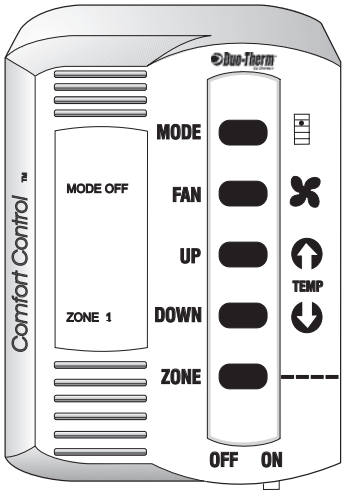


630515 & 630516 WIRING DIAGRAM



Duo-Therm® By Dometic

COMFORT CONTROL CENTER™
Part No. 3109228.001



C US

This Comfort Control Center will provide your cooling and heating requirements regardless of your vehicle size.

USA
SERVICE OFFICE
The Dometic Corp.
509 So. Poplar St.
LaGrange, IN 46761
(219) 463-4858

CANADA
Dometic Dist.
866 Langs Dr.
Cambridge, Ontario
CANADA N3H 2N7
(519) 653-4390

For Service Center Assistance Call:
800-544-4881

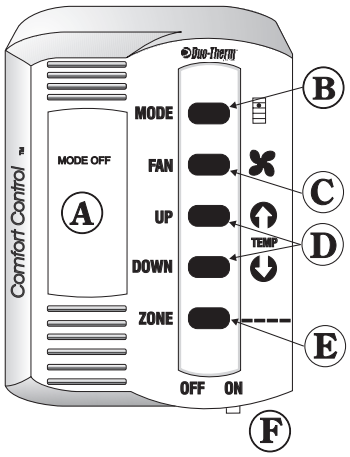
OPERATING INSTRUCTIONS

Comfort Control Center™
Part No. 3109228.001

REVISION
Form No. 3108664.032 1/01
(Replaces 3108664.024)
(French 3109564.024

Your recreational vehicle manufacturer has equipped your vehicle with Duo-Therm's Comfort Control Center™. The Comfort Control Center has been designed for you to easily operate all the air conditioning and gas heating appliances found in your vehicle from one location.

In order to familiarize yourself with the operation of the Comfort Control Center, the following diagram along with the accompanying text will explain all the functional characteristics of the system.



A. Liquid Crystal Display
B. Mode Selector Button
C. Fan Speed Selector Button
D. Temperature Selector Buttons
E. Zone and Stage Selector
F. On/Off Switch

A. **LIQUID CRYSTAL DISPLAY** – Your Comfort Control Center is equipped with a liquid crystal display (LCD) that identifies the mode of operation, the temperature set-point, the zone identification and the fan speed. The Comfort Control Center is designed to accept and control many varied air conditioning and gas heating appliances. When you begin to first operate your Comfort Control Center, you will see that the LCD readout will only show the options available based on the appliances installed on your vehicle. An incandescent light will illuminate the LCD area when a selector button is pushed for easy reading at all times.

B. **MODE SELECTOR BUTTON** – Modes of operation available are: **OFF, FAN ONLY, COOL, HEAT PUMP**, **FURNACE, HEAT STRIP and AUX. HEAT**. Remember, your LCD readout will only show the options available based on the appliances installed on your vehicle. To select the mode of operation, momentarily depress the **MODE** push-button. You will need to continue to depress and release the button until the desired mode is shown in the LCD readout area on the Comfort Control Center.

   To determine the Comfort Control Center options available to you, depress and release the **MODE** push-button until it goes through all selections.

C. **FAN SPEEDS** – Possible available fan speeds are: **LOW, MEDIUM, HIGH** and **AUTO**. To select the desired fan speed, momentarily depress the **FAN** push button. You will need to continue to depress and release the **FAN** button until the desired fan speed is shown in the LCD readout area of the Comfort Control Center.

D. **TEMPERATURE SELECTOR BUTTONS** – The temperature Set-point range is from 40° to 99° Fahrenheit or 4° to 37° Celsius. Determination of Fahrenheit or Celsius standard is done at the time of your manufacturer's installation of the Climate Control Center. To set the temperature at your comfort level, simply depress and release the **UP** or **DOWN** push-button until the desired temperature is shown in the LCD readout area of the Comfort Control Center.

E. **ZONE SELECTOR BUTTON** – A **ZONE** is also established at the time of installation of your Comfort Control Center. If you have one air conditioner, you will have one **ZONE**. If your vehicle has more than one cooling system, depending on the manufacturing installation, you may have 2, 3 or 4 **ZONES**. Zones are defined and preset by your manufacturer. A zone is an area of cooling/heating which is controlled independently within that area, and regulated at the Comfort Control Center. A typical example of a two zone application would be a vehicle with two air conditioning systems, one in the front area (living room, kitchen) and one in the back section (bedroom and bath). The front area could be established as **ZONE 1** and the back section **ZONE 2**. You can select the desired temperature and fan speeds for each zone independently, thereby keeping your bedroom cooler than the front portion of the vehicle. To determine the number of established zones in your vehicle, depress the **ZONE** push-button. **ZONE 1** will be the first **ZONE** to appear in the LCD readout. The **ZONE** number selected will begin to flash and will flash for approximately 30 seconds or until another **ZONE** has been selected. Continue to depress and release the **ZONE** button until you see **ZONE 1** reappear.

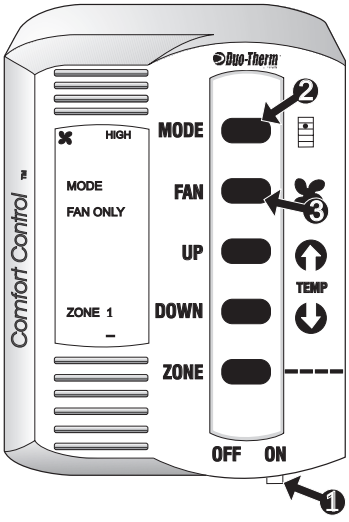
F. **ON/OFF SWITCH –** The ON/OFF switch is located on the lower right hand edge of the Comfort Control Center. Move the lever from side to side to change status.

OPERATING YOUR DUO-THERM COMFORT CONTROL CENTER

The Comfort Control Center allows you the freedom of controlling your vehicle's temperature to provide you with a comfortable environment to enjoy your life-style. With just a few simple steps, you can control which mode of operation you will use, the vehicle temperature and the fan speeds.

A. FAN ONLY MODE OF OPERATION

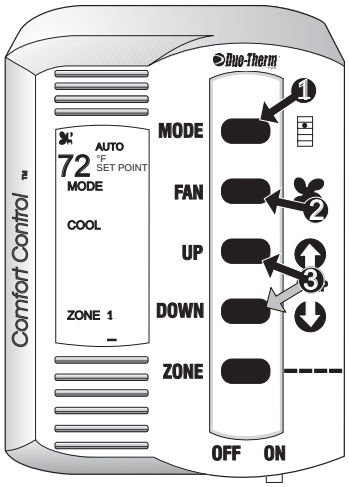
1. Begin by placing the power switch on the lower right hand edge of the Control Center on the **ON** position. To do this, simply move the lever to the right.
2. Momentarily depress and release the **MODE** push-button until the **FAN ONLY** indicator on the Liquid Crystal Display (LCD) is illuminated.
3. Momentarily depress and release the **FAN** push-button until the desired fan speed indicator (**LOW, MED, HIGH, AUTO**) is illuminated. If your vehicle is equipped with a heat pump or a dual basement air conditioning system, your selection choice will be **LOW**, **HIGH** or **AUTO**.
4. After approximately 5 seconds, the selected fan speed will come on. The **MODE** and **FAN** speed you have selected will remain shown in the LCD area of the Control Center until you change your selection.
5. If your vehicle contains more than one **ZONE**, depress the **ZONE** push-button to select **ZONE 2**, and repeat procedures from step two above. Repeat entire procedure for each additional zone.



B. COOLING MODE OPERATION

(To set cooling temperatures and fan speeds on Duo-Therm Air Conditioners & the cooling mode of Duo-Therm Heat Pumps)

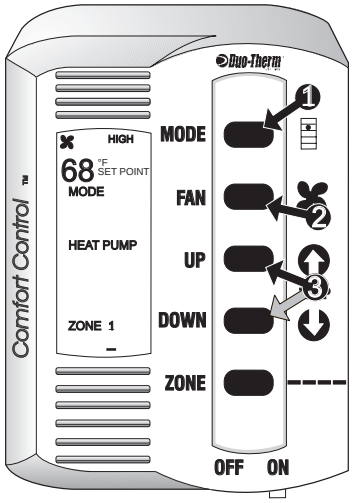
1. Momentarily depress and release the **MODE** push-button until the **COOL** indicator on the LCD is illuminated.
2. Depress and release the **FAN** push-button to select your desired fan speed (**LOW**, **MEDIUM**, **HIGH** or **AUTO**). If your vehicle is equipped with a heat pump or a dual basement air conditioner system, your selection choice will be **LOW**, **HIGH** or **AUTO**.
3. Depress and release the **UP** push-button to increase the temperature or the **DOWN** push-button to decrease the desired temperature. The final selected **SET-POINT** will be displayed in the LCD area of the Comfort Control Center.
4. After a delay of approximately 2 minutes the air conditioner's compressor will come on and the cooling process will begin. Once the room temperature reaches the selected **SET-POINT**, the compressor will cycle off. Once the Comfort Control Center senses the need for cooling, the compressor will restart in approximately two minutes. At this point, the fan will either:
   a.continue to operate in the single selected fan speed or,
   b.cycle **OFF** and **ON** with the compressor if the **AUTO** fan speed has been selected.
5. If your vehicle contains more than one **ZONE**, depress the **ZONE** push-button to select **ZONE 2**, and repeat procedures from Step 1. Repeat entire procedure for each additional zone.



C. HEAT PUMP OPERATION

(To set heating temperatures for vehicles equipped with a Duo-Therm rooftop or basement heat pump. To operate cooling mode with a heat pump, see "B. Cooling Mode Operation", Page 3.)

1. Momentarily depress and release the **MODE** push-button until the **HEAT PUMP** indicator on the LCD is illuminated.
2. If you have not previously set your fan speed, you may do so by depressing and releasing the **FAN** push-button to select the desired fan speed.
3. Depress and release the **UP** push-button to increase the temperature or the **DOWN** push-button to decrease the desired temperature. The final selected **SET-POINT** will be displayed in the LCD area of the Comfort Control Center.
4. After a delay of approximately 2 minutes the heat pump's compressor will come on and the heating process will begin. Once the room temperature reaches the selected **SET-POINT**, the compressor will cycle off. Once the Comfort Control Center senses the need for heating, the compressor will restart in approximately two minutes. At this point, the fan will either:
   a. continue to operate in the single selected fan speed or,
   b. cycle **OFF** and **ON** with the compressor if the **AUTO** fan speed has been selected.
5. If your vehicle contains more than one **ZONE**, depress the **ZONE** push-button to select **ZONE 2**, and repeat procedures from Step 1 above. Repeat entire procedure for each additional zone.

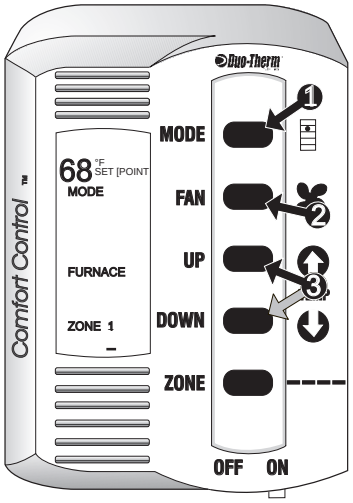


NOTE:
See Page 7, Items F & G for additional Special Heat Pump Features.

D. FURNACE MODE OPERATION

(If your vehicle is equipped with a gas furnace connected to the Comfort Control Center)

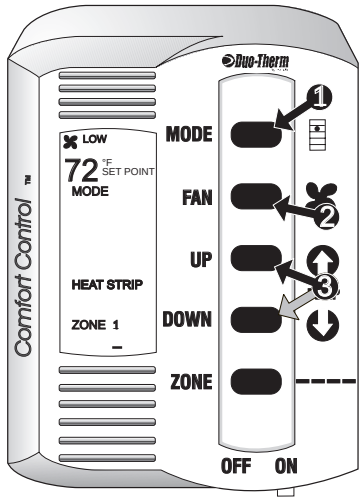
1. Momentarily depress and release the **MODE** push-button until the **FURNACE** indicator on the LCD is illuminated.
2. The A/C fan does not operate in the **FURNACE** mode.
3. Depress and release the **UP** push-button to increase the temperature or the **DOWN** push-button to decrease the desired temperature. The final selected **SET-POINT** will be displayed in the LCD area of the Comfort Control Center.
4. Your Duo-Therm air conditioning system will not operate when the Comfort Control System is in the **FURNACE** mode. For cooling, change the **MODE** to **COOL**.
5. If your vehicle contains more than one **ZONE**, depress the **ZONE** push-button to select **ZONE 2**, and repeat procedures from Step 1 above. Repeat entire procedure for each additional zone.



E. HEAT STRIP MODE OPERATION

(For Duo-Therm air conditioners with an electric heat strip)

1. Momentarily depress and release the MODE push-button until the **HEAT STRIP** indicator on the LCD is illuminated.
2. The fan will operate in **LOW, MED** or **AUTO**. You will not be able to select **HIGH** speed when in the **HEAT STRIP** mode. Depress and release the **FAN** push-button to select desired speed. If your vehicle is equipped with a heat pump or a dual basement air conditioner system, your selection choice will be **LOW** and **AUTO**.
3. Depress and release the **UP** push-button to increase the temperature or the **DOWN** push-button to decrease the temperature. The final selected **SET-POINT** will be displayed in the LCD area of the Comfort Control Center.
4. The electric heat strip will cycle **ON** and **OFF** per the temperature **SET-POINT** displayed. The fan will either:
   a. continue to operate in the selected fan speed or,
   b. cycle **OFF** and **ON** with the heat strip if the **AUTO** fan speed has been selected.
5. If your vehicle contains more than one ZONE, depress the **ZONE** push-button to select **ZONE 2**, and repeat procedures from Step 1 above. Repeat entire procedure for each additional zone.



COMFORT CONTROL CENTER SPECIAL CONTROL FEATURES

A. AUTO FAN

When **AUTO FAN** is selected, the fan speed will be determined by the mode you are in.

1. **COOL MODE** – In the **COOL** mode, which is the air conditioning mode, the fan will automatically select the speed depending upon the difference between the temperature **SET-POINT** and the room temperature. When that difference is:

8° or more	The fan will operate on **HIGH**
4° to 8°	The fan will operate on **MED**
4° or below	The fan will operate on **LOW**

2. **COOL MODE (Heat Pump and Basement units)** – If your vehicle is equipped with a Duo-Therm Heat Pump or Basement unit, the fan will automatically select the fan speed depending upon the difference between the temperature **SET-POINT** and the room temperature.

   When the difference is:

8° or more	– The fan operates on **HIGH**
Less than 8°	– The fan operates on **LOW**

3. **HEAT PUMP MODE –** When **HEAT PUMP** mode is selected, the fan will start running in the **LOW** speed.
4. **HEAT STRIP MODE** – When **HEAT STRIP** mode i selected, the fan will start running in the **LOW** speed
5. **FAN ONLY MODE** – In the **FAN ONLY** mode, the fa will start running in the **LOW** speed.

B. REFRIGERANT COMPRESSOR TIME DELAY

A time delay of approximately two minutes occurs an time the compressor is required to begin the cooling c heat pump cycle.

C. POWER INTERRUPTION

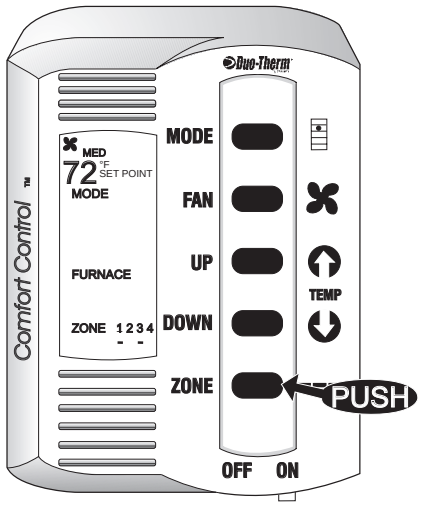
In the event that power to the air conditioner or control i interrupted, the system will restart with the same se tings you have previously set.

D. ZONE CONTROL

Your Duo-Therm Control Center will operate cooling an heating appliances which your vehicle manufacturer ha designed to heat or cool different areas (**ZONES**) of you RV. The Comfort Control Center will advise you if you vehicle has multiple **ZONES**, by showing **ZONE 1, 2 3** c

(*D. Zone Control continued*)

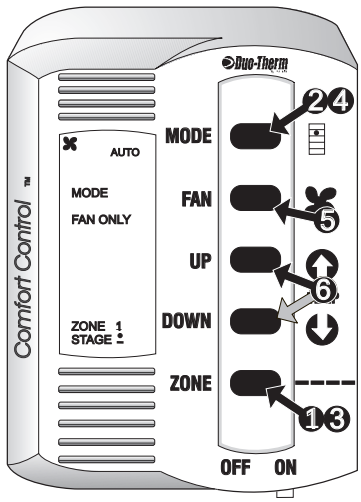
4 illuminated in the LCD readout. In the event your vehicle has multiple zones designed, you have the freedom of selecting the **MODE** of operation for each zone independently. To change from one zone to another, depress the **ZONE** push-button. Each time you depress and release this push-button, the indicator will change the zone data displayed. The zone number flashing indicates zone being programmed. The zone number will flash for approximately 30 seconds unless another zone is selected or programming has been completed. At this time the number will stop flashing and the desplay light will go out.When all zones have been programmed, the zones in operation will be underlined. To program each zone, simply repeat the programming steps shown in the operation section of this manual. Please note: The Comfort Control Center will prevent operating **FURNACE** and **COOL** or **FURNACE** and **HEAT PUMP** at the same time.



E. STAGE CONTROL OPERATION

If your vehicle is equipped with a Duo-Therm Dual Basement Air Conditioner or a Dual Basement Heat Pump, you have an air conditioning system that is designed to optimize comfort and running efficiencies. (Two units within one compartment). This is accomplished as long as the required electrical power is available, by providing an on-demand secondary stage of operation. (NOTE: The primary stage will continue to operate even if there isn't enough electrical power available to run the second stage.) The Comfort Control Center simplifies this operation and allows you to set the primary temperature set-point while the differential temperature set-point which activates the secondary stage is preset. After turning on your Comfort Control Center, perform the following steps to set and activate the stage control operation.

1) Momentarily depress the **ZONE** push-button to select stage in the zone desired
2) Momentarily depress the **MODE** push-button to select "**ON**".
3) Momentarily depress the **ZONE** push-button to select the zone where stage was selected in Step 1.
4) Momentarily depress the **MODE** push-button until the desired mode of operation is selected (**FAN ONLY**, **COOL** or **HEAT PUMP**).
5) Momentarily depress the **FAN** push-button until the desired fan speed is displayed (**LOW**, **HIGH** or **AUTO**).
6) Momentarily depress the **UP** and **DOWN** push-button until the desired room temperature set-point is displayed.

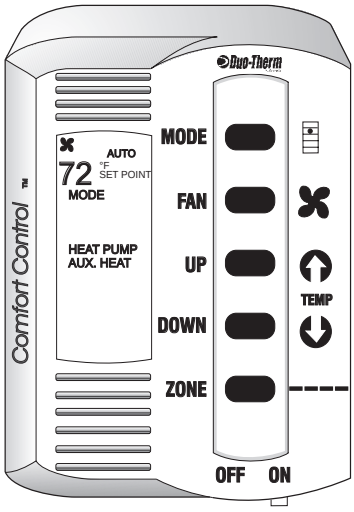


F. AUX. HEAT

When in the **HEAT PUMP** mode, if the outside ambient temperature is measured to be below 30°F and the vehicle is equipped with a furnace connected to the Comfort Control Center, the control will automatically select the **FURNACE** operation and the **HEAT PUMP** will shut down.

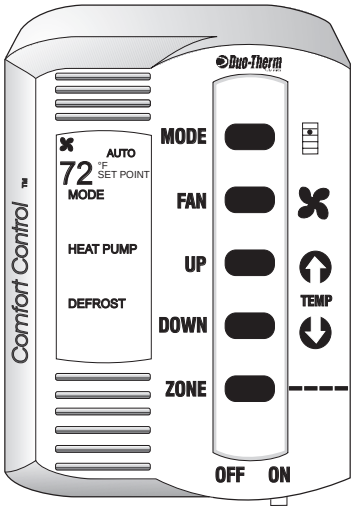
Important: If vehicle is not equipped with a furnace no heat will be available below 30°F. IF vehicle is equipped with a furnace and it is connected to its own thermostat, it must be manually turned ON and OFF for operation.

When this happens, the **AUX. HEAT** and the **HEAT PUMP** indicators on the LCD will illuminate. Once the outside ambient temperature is measured above 38°F, the control will return to the **HEAT PUMP** operation and shut down the furnace if it is connected to the Comfort Control Center. If furnace is not connected to the Comfort Control Center, the furnace thermostat must be manually turned off.



G. DEFROST CYCLE

This cycle is active during **HEAT PUMP** operation and allows the heat pump to operate down to 30°F. When the outside ambient temperature is less than 42°F and greater than 30°F, a defrost timing cycle will begin. The defrost timing cycle will allow operation of the heat pump for 25 minutes. The fan will then be shut off, the refrigerant flow reversed and run for 4-1/2 minutes, this is the **DEFROST** cycle. The refrigerant flow will then be returned to normal and, after a 30 second delay will continue until the temperature is greater than 42°F or until the temperature becomes less than 30°F, at which time the furnace will activate. (See **AUX. HEAT**). During the defrost cycle, the **DEFROST** indicator on the LCD shall be illuminated.

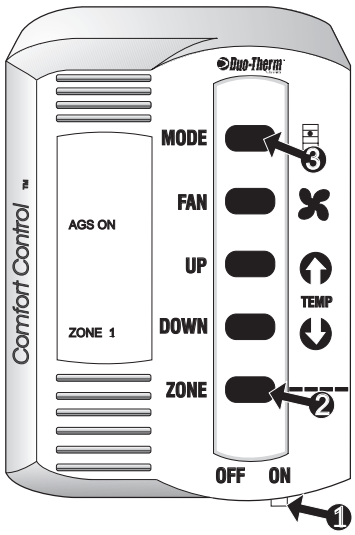


H. OPTIONAL AUTOMATIC GENERATOR START (AGS)

On vehicles equipped with an optional AGS kit the vehicle generator will automatically start when any zone calls for cooling and will shut off when all zones reach set point.

1. Put the power switch in the ON position.
2. Momentarily depress and release the ZONE push-button until AGS indicator appears on the LCD.
3. Momentarily depress and release the MODE push-button to select AGS status.

Important: When shore power is available, AGS must be switched to the off position.



GENERAL INFORMATION

A. The ability of the air conditioner to maintain the desired inside temperature depends on the heat gain of the RV. Some preventative measures taken by the occupants of the RV can reduce the heat gain and improve the performance of the air conditioner. During extremely high outdoor temperatures, the heat gain of the vehicle may be reduced by:

   1. Parking the RV in a shaded area.
   2. Using window shades (blinds and/or curtains).
   3. Keeping windows and doors shut or minimizing usage.
   4. Avoiding the use of heat producing appliances.

   Starting the air conditioner early in the morning and giving it a "head start" on the expected high outdoor ambient will greatly improve its ability to maintain the desired indoor temperature.

B. The manufacturer of this air conditioner will not be responsible for damage caused by condensed moisture on ceilings or other surfaces. Air contains moisture and this moisture tends to condense on cold surfaces. When air enters the RV, condensed moisture may appear on the ceiling, windows, metal parts, etc. The air conditioner removes this moisture from the air during normal operation. Keeping doors and windows closed when this air conditioner is in operation will minimize condensed moisture on cold surfaces.

C. This equipment must be serviced by qualified personnel and some states require these people to be licensed.

MAINTENANCE

AIR FILTER: Periodically remove the return air filter. Wash the filter with soap and warm water; let dry and then reinstall or replace as required.

Note: Never run the air conditioner without the return air filter in place. This may plug the unit evaporator coil with dirt and may substantially affect the performance of the unit.

Comfort Control Center™: Clean the Comfort Control Center™ with a moist, soft cloth. **DO NOT** use solvents for cleaning.

SERVICE

If your unit fails to operate or operates improperly, check the following before calling your service center.

A. If your RV is connected to a motor generator, check to be sure the motor generator is running and producing power.
B. If the RV is connected to a power supply by a land line, check to be sure the line is sized properly to run air conditioner load and it is plugged into the power supply.
C. Check your 115VAC fuse or circuit breaker to see if it is open.
D. Check your 12VDC fuse or circuit breaker to see if it is open.
E. After the above checks, call your local service center for further help. This unit must be serviced by qualified service personnel only.

When calling for service, always give the following:

A. Air Conditioner Model Number and Serial Number found on Rating Plate located on the Base Pan of the air conditioner.
B. Electronic Control Kit Part Number and Serial Number found on Rating Plate located on the side of the Kit.

RETURN AIR GRILLE MUST BE REMOVED FROM THE RETURN AIR COVER TO VIEW THESE RATING PLATES.

MICROFLUSH® Half Gallon Toilets
Air Operated

Model LF-210 Model LF-219

Installation/Service Manual

P/N 24563

Microphor
A Wabtec company

452 East Hill Road, Willits, CA 95490 USA
Tel: 707.459.5563 • Tel: 800.358.8280 • Fax: 707.459.6617
www.microphor.com • www.wabtec.com

THANK YOU FOR PURCHASING A MICROPHOR PRODUCT!

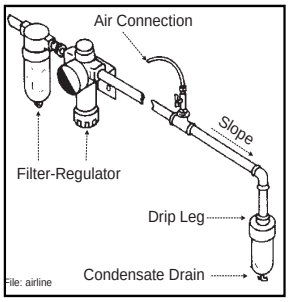
Your Microflush® toilet is designed to provide you with years of reliable service while using only two quarts of water per flush. Please read this Owner's Manual completely prior to installation of your Microflush toilet. This will familiarize you with all of the proper installation and operation requirements.

CUSTOMER SERVICE

Please contact your local Microphor dealer for parts and service. For a list of dealers, please contact Microphor at 1-800-358-8280 or visit our website at www.microphor.com.

AIR SYSTEM

Filter-regulators are available in a variety of sizes and types. Their purpose is to remove water, oil and other foreign matter from the air line and to maintain a constant pressure **at the toilet of 60-65 PSI**. The following steps must be observed to assure moisture will be removed from the airline:



1. Drain air compressor receiver regularly. Most water tends to accumulate at this point.
2. Install drip legs with condensate drains at all low points in air piping.
3. Whenever possible, grade all airlines back to the air receiver or drip leg assembly and drain regularly.
4. The air supply to your Microflush toilet must be taken from the top of the main or branch air line.

AIR COMPRESSOR

Be certain compressor crankcase has proper oil levels. Locate the compressor in a clean, dry, well ventilated location. Size compressor according to separate Air Compressor Specifications Sheet.

PRE-INSTALLATION

The following procedures apply to all Microflush models unless otherwise noted. Remove your toilet from box carefully. Integral Models - Install toilet seat and flush handle before mounting Microflush to floor. Seat is not included. Bolt caps and closet screws are provided.

1. AIR LINES

If used in Marine applications, all piping supplied by customer is to conform to U.S.C.G. requirements relating to water tight decks and bulkhead (46CFR56.69)

Be sure airline from compressor is of sufficient size, based on length of pipe run to head. We suggest 3/8" air line up to 40', 1/2" air line up to 75', and 3/4" air line for over 75'.

Install a filter-regulator assembly in incoming airline. Place the filter-regulator as close as possible to the first Microflush toilet and in an accessible location.

Set filter-regulator so that **60-65 PSI constant is available at the toilet**. Install Microphor combination filter/regulator/dryer, P/N 94036.

Assemble the Air Connecting Kit provided and connect to incoming air line with shut-off valve between bulkhead and toilet. For LF-210 Models, use Air Connecting Kit P/N 93086, and for LF-219 Integral Models use Air Connecting Kit P/N 95172. The plastic airline provided goes from the air supply to the Flush Activator. On integral models, the plastic air line enters the Microflush through the back wall or up through the floor under the unit. Make sure air is OFF at air compressor. **DO NOT CONNECT TO FLUSH ACTIVATOR YET!**

2. WATER LINES

Use a 1/2" water line and install a water shut-off valve (angle stop) between bulkhead and toilet. Water **at the toilet** must be regulated at an even pressure between **20 to 50 PSI** for Microflush to operate properly. Optimum pressure is 35 PSI. **DO NOT CONNECT WATER LINE TO MICROFLUSH YET!**

INSTALLATION PROCEDURES

3. DRAIN CONNECTION - See Rough-In Dimensions

FOR ALL INSTALLATIONS:

LF-210 Downward Discharge Model: Rest Microflush on its back on a padded surface (e.g. shipping box). Center wax ring over Hopper Flange. Turn Microflush toilet over, lift up, and center it with the horn of the wax ring into standard floor flange. Compress the wax ring by applying weight to your Microflush toilet. A second standard wax ring may be added if floor is uneven. If Hopper Flange hits floor flange, grind it down for added clearance, as any contact will break seal between Hopper and Toilet Bowl and cause leaking.

Note: Discharge on toilet is 13.25 (+/- 0.5") from back. See rough in dimensions.

All Rear Discharge Models: Install inverted P-Trap supplied with Microflush toilet. Do not glue or connect fittings until fitting alignment has been checked.
Caution: Outlet is 3/4" off centerline. Make sure toilet discharge and waste line are in line, not off set.

LF-219 Model: For downward discharge, use molded P-Trap hose supplied. For rear discharge, use inverted P-Trap. See page 8 for part numbers.

Remote Models: Position and mount the Remote Valve Assembly making sure the Vacuum Breaker is at least 6" above the rim of the Microflush toilet bowl. Measure air and water lines to make sure Remote Valve is mounted within connection distance to Microflush toilet. Run water and the three air lines from the Remote Valve Assembly to Microflush.
Caution: For Remote Flush Activators, make sure inside wall thickness does not exceed 1/2" or large mounting nut will restrict movement of flush handle.

Mount toilet bowl to floor with 1/4" closet bolts provided. Screw on bolt caps to mounting screws.

When using a 1-1/2" (38.1 mm) discharge line, each toilet must go individually to the Marine Sanitation Device or holding tank. Do not connect more than one toilet to a 1-1/2" (38.1 mm) discharge line.

If a vertical rise is required, the vertical rise must be at the toilet. The maximum vertical rise is 36". Vertical rise is not recommended for high use applications. The maximum horizontal run is 30 feet (9.14 meters) and must slope a minimum of 1/8" per foot (1 in 100) towards the Marine Sanitation Device or holding tank. For 1-1/2" lines, reduce horizontal pipe run 2 feet (.68 meters) per 90° elbow. Use long sweep elbows.
Note: The use of regular 90° elbows will significantly decrease the horizontal run.

When multiple toilets are installed, a vented 3" gravity collection line is to be used with not more than 4 toilets per 3" line. Manifold the 1-1/2" lines into the 3"collection line and provide a grade of at least 1/4" per foot towards the Marine Sanitation Device or holding tank. Vent 3" line at the manifold point.
Caution: Do not apply stress to align Microflush rear or downward discharge outlet to waste line. This may result in eventual damage to seal between Hopper and Toilet Bowl and cause leaking.

FOR MARINE INSTALLATIONS:

For direct overboard discharge, contact Microph your dealer.

4. WATER CONNECTION

Never install a check valve on the inlet side of the Microflush toilet.

Integral Models - Connect incoming water from a stop to water connector. Make sure WATER IS OF angle stop.

LF-210 Models - Water supply connector is made nylon-plastic; be careful not to cross threads.

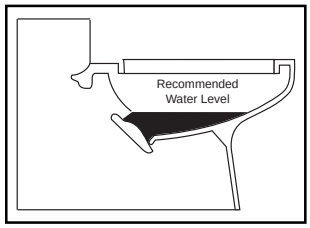
LF-219 Models - If integral model is connected to potable water source, the unit requires installer to a Back Flow/Cross Contamination Prevention devi Please check applicable jurisdiction for requireme before installation.

Remote Models - Connect incoming water from a stop to Microflush Hose Barb on the Remote Valve Assembly. Connect the water line from Remote Va Assembly to the Flush Rim Spud Assembly. Make WATER IS OFF at angle stop.

START UP

1. Turn ON air supply at compressor.
2. Turn air ON at air shut-off cock (near but not c nected to Flush Activator) to blow out airlines few seconds. This procedure should remove a debris or contaminants from the airline. Turn at shut-off valve.
3. Connect airline to Flush Activator. Make sure shut-off valve is installed next to Flush Activat not over-tighten fittings.
4. Turn ON air shut-off cock. Check total install for air leaks using soapy water.
5. Turn ON water. Check for water leaks.
6. Flush your Microflush toilet four times, waitin twenty seconds between flushes to get water th system and operating regularly. To flush prope hold down Flush Activator Handle or Button u flapper opens.

DOUBLE CHECK



1. Air pressure at Microflush toilet is at least 60-65 PSI.
2. Water Pressure at Microflush toilet is between 20-50 PSI, 35 PSI optimal.
3. Water level in bowl should be at top edge of flapper opening.
4. If your Microflush does not operate correctly, refer to troubleshooting sections.

FLUSH CYCLE ACTIVATORS

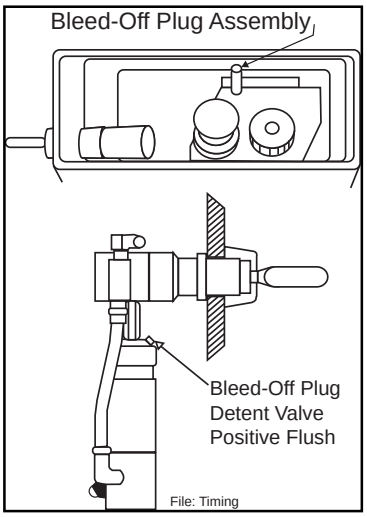
There are two types of Flush Activators:
Standard - hold handle or button down for 1 second.
Positive - barely push handle or button to activate.

CLEANING BLEED-OFF PLUG ASSEMBLY

Standard Flush:
Remove plug and clean with solvent; air blow dry.

Positive Flush:
Remove plug and clean with solvent; air blow dry; remove and clean plug on Detent Valve.

Note: Use 5/32"or 4mm Allen wrench to remove plugs.



Note: Bleed-Off plugs on Air & Water Sequence Valves and Detent Valves are different sizes that are not interchangeable.

MAINTENANCE/CLEANING/CLEARING/ WINTERIZING

ROUTINE MAINTENANCE

USAGE	LUBRICATE
Light	Every 5 years
Medium	Every 2-3 years
Heavy	Every year

Your Microflush toilet has an air-operated Air/Water Sequence Valve which requires periodic lubrication with a silicone based lubricant. Check your application at right to determine how often to lubricate your Air/Water Sequence Valve. The Air Cylinder should be serviced if you have to take up your Microflush toilet for any reason. **The air system must be free of moisture. Drain air receiver regularly to remove moisture.**

CLEANING

Use Micro-Clean Organic Spray Cleaner, P/N 24542. **Sanitizers like Lysol, Pine-Sol, Hexol, ammonia base products, caustic drain openers or non-biodegradable cleaners should never be used if the plumbing system is connected to a Microphor Marine Sanitation Device.**

1. While depressing the Flush Activator, turn OFF the water. Allow the bowl cleaner to flow into the lower chamber. Keep the Flushing Activator depressed.
2. Insert bowl brush into lower chamber and agitate mixture carefully. Remove the bowl brush and release the flush activator.
3. Turn the water ON and flush twice to rinse thoroughly.

Use MicroScrub, P/N 24827, to clean the hopper.

1. Turn off water and depress flush activator.
2. Dispense 1/2 bottle of MicroScrub into the hopper.
3. Turn on water and allow MicroScrub to stay in the hopper as long as possible before flushing.

CLEARING YOUR MICROFLUSH TOILET

If your Microflush toilet becomes plugged, shut off the water supply, press the flush handle and hold. The flapper will remain open until flush handle is released. Check to see if the restriction can be removed from lower portion of Microflush toilet with a hooked wire, being careful not to damage the rubber seal on the flapper or the mating surface on the hopper. If obstruction cannot be picked out with a hook or tongs, use plunger by pushing in slowly and pulling out quickly to pull object back into the hopper. If necessary, turn air off and use a snake inserted through a short plastic pipe placed in hopper. Pipe will protect flapper seal. If valve will not operate with water off, hold flush lever down and turn water on and off quickly to free valve action. When the

passage becomes clear, turn on water and press flush handle to start flush cycle.

WINTERIZING (Out-of-Service Winter Storage)
Shut OFF water to Microflush toilet. Flush Microflush toilet three times or until water no longer flows into the bowl. Unhook water supply at angle stop. Empty water in line into receptacle. Shut OFF air supply to your Microflush toilet. The unit is now prepared for freezing temperatures. OPEN petcocks on drip legs and air receiver drain after shutting down air compressor and isolating airlines.

WARNINGS

- *Do not use any petroleum based lubricants (Vaseline) on any rubber parts or o-rings as damage will occur. Use only silicone based lubricants.*
- *Do not use any 'Locktite' brand adhesives on any plastic or Delrin components as fumes will cause damage.*
- *Do not use Teflon tape on any air fittings as clogging may occur.*

PATENTS
Microflush® Toilets are covered by one or more of the following U.S. patents: 5245710; 4918764; 1280554; 169471 and related foreign patents.

DESIGN CHANGES
Continuing a policy of research and development, Microphor reserves the right of price, product or design change without notice or obligation.

TROUBLESHOOTING

Your Microflush® toilet is designed to give you years of trouble-free operation. Please check the following before beginning any service or repair:

Water supply:

1. Is the water turned on?
2. Is the water pressure between 20 and 50 PSI at the toilet for pressure water system?
   Fluctuating or high water pressure can cause intermittent problems with the toilet operation. Check the water pressure at different times of the day (i.e., early morning, noon, evening) to determine if you have fluctuating or high water pressure. A pressure-reducing valve installed on the incoming water line will assure you have even pressure. Make sure no check valve is installed before the Air/Water Sequence Valve.
   *Note: Water seal of flapper does not require complete submersion as flapper seal gasket provides complete hopper seal.

Air system:

1. Is the air turned on?
2. Is the air pressure set at a constant 60-65 PSI at the toilet?
3. Do you have any air leaks or kinks in the air system?
4. Do you have water in the air system? This usually causes irregular timing.
   Drain the compressor tank and check the filter regulator and drip leg(s) for water. To check for water in Air/Water Sequence. Valve, remove Bleed Off Plug, put finger over screw opening and flush. If water is present, it will squirt from sides of valve body. If water is detected, then the air cylinder and airlines must also be drained.

Cycle time:

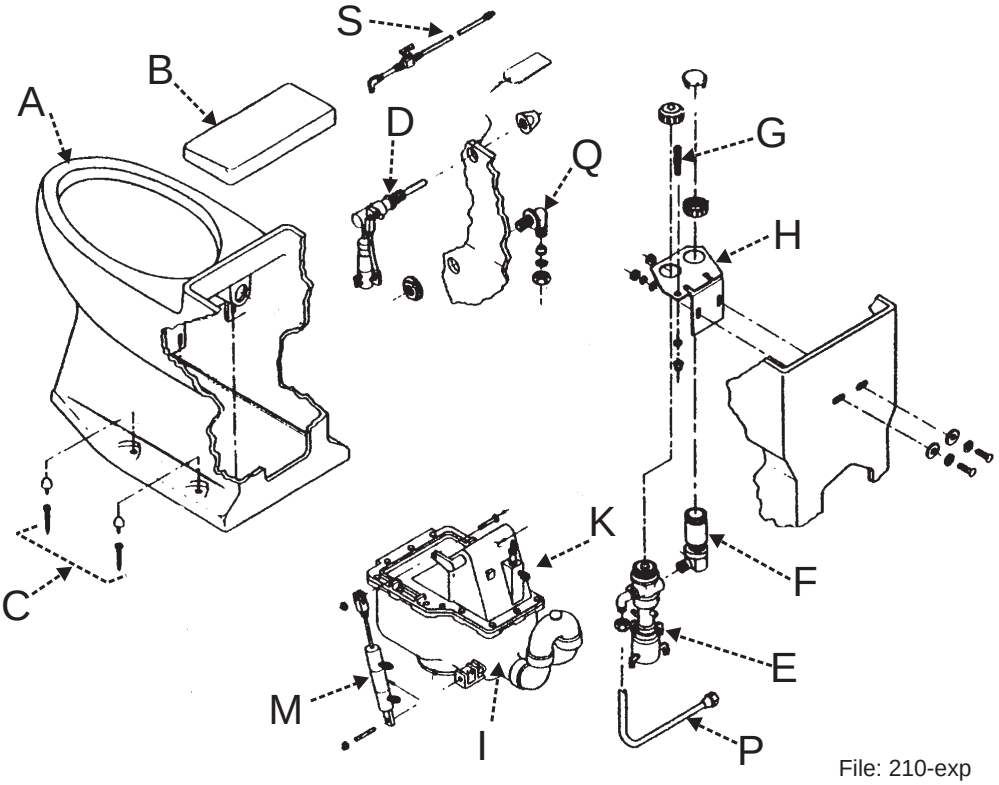
1. Is the flapper cycle time set correctly at 4-7 seconds?
2. Is the bleed off plug blocked? Remove, clean and reinstall or replace.

Trouble	Possible Causes	Correction
Flapper does not open. Water does not flow. Nothing happens.	1. No air supply to toilet 2. Water has accumulated in Air/Water Sequence Valve	1. Supply compressed air at 60-65 PSI at the toilet 2. See 'Check Air System" above
Flapper opens and closes 4-7 seconds after handle is released, but no water enters bowl	1. No water supply to toilet 2. Water turned off	1. Supply water at 20-50 PSI 2. Open angle stop (shut-off valve)
Flapper opens when flushed, and closes immediately when activator is released	1. Excessively high water pressure 2. Debris in check valve at base of Air/Water Sequence Valve	1. Install water pressure regulating valve, set at 20-50 PSI 2. Clean Air/Water Sequence Valve
Flapper opens and will not close	Bleed Off plug blocked	Remove, clean or replace, reinstall
Water continues to run when toilet is not in use	Foreign object is under water seal in Air/Water Sequence Valve	Clean, replace or rebuild Air/Water Sequence Valve
Water splashes when flushed	Water is too high in bowl	Reduce incoming water via angle stop (shut-off valve)
Flush cycle is too long	Bleed-Off Plug blocked	Remove, clean or replace, reinstall
Flush cycle is too short	Air line leakage	Check for air leakage at all connections

If other problems are encountered, please contact Microphor toll-free at 1-800-358-8280.

EXPLODED VIEWS

A Toilet Shell
B Toilet Lid
C Closet Screws
D Flush Activator
E Air/Water Seq. Valve
F Vacuum Breaker
G Bleed Off Plug
H Valve Bracket
I Hopper Assembly
J P-Trap, Rear Discharge
K Hopper Bleed Valve
L Hopper Screws
M Air Cylinder
N Flapper Assembly
O Crank Assembly
P Water Supply Tube
Q Water Connection
R Hopper Gasket
S Air Supply Kit
T Pressure Relief Valve



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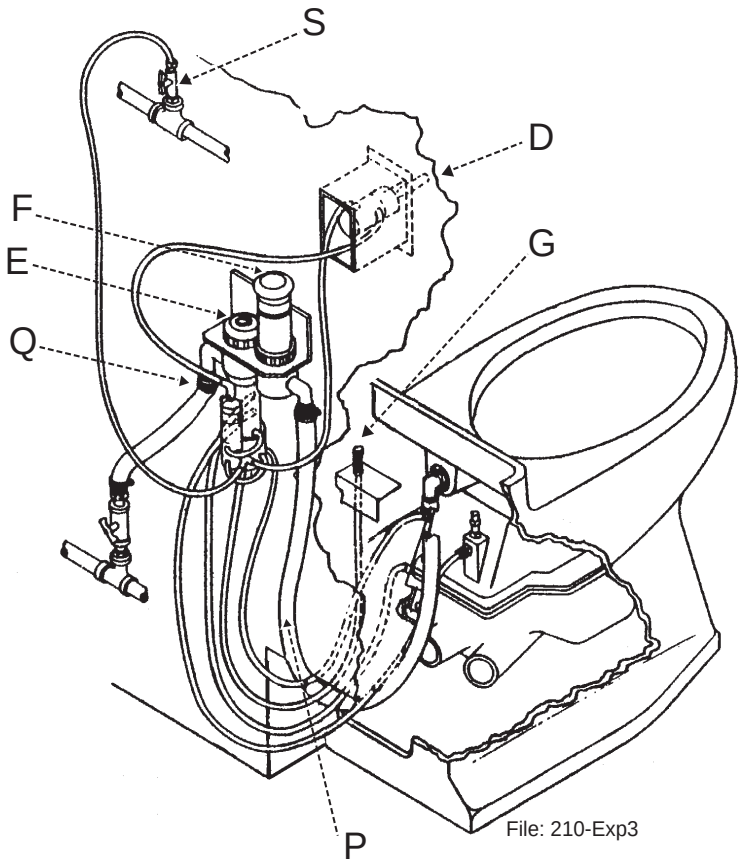
Typical Remote Assembly



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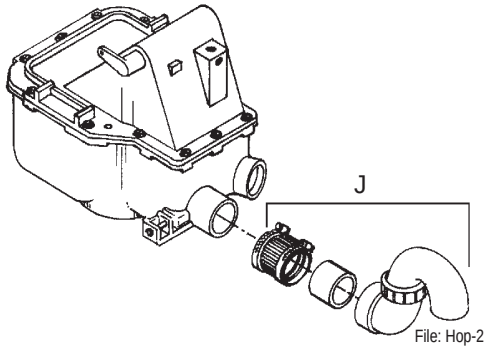
Rear Discharge Hopper



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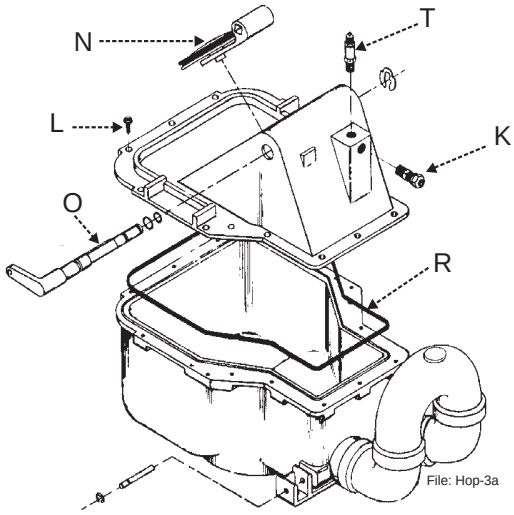
Downward Discharge Hopper



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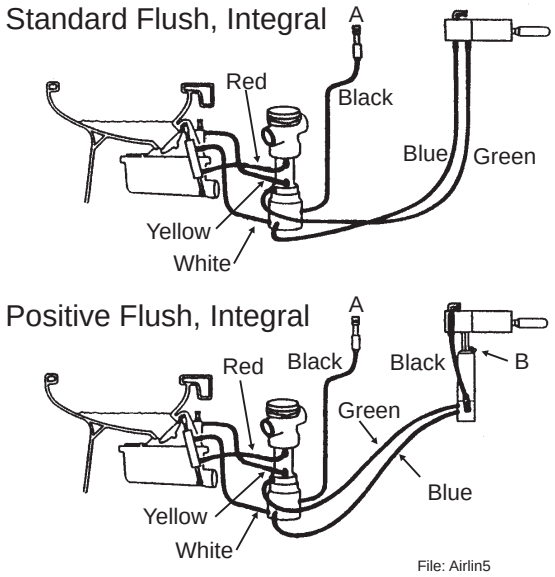
PARTS CHART

		LF-210 Round	LF-210 Elongated	LF-219 Round	
				Integral	Remote
A	Toilet Shell				
	White	93734	93732	93682	93683
	Biscuit	93734-3	93732-3	93682-3	93683-3
	Black	93734-5	93732-5	93682-5	93683-5
	Gray	93734-7	93732-7	93682-7	93683-7
B	Toilet Lid				
	White	94537			
	Biscuit	94537-3		Not Applicable	
	Black	94537-5			
	Gray	94537-7			
C	Closet Screws & Bolt Caps				
	White	93972			
	Biscuit	44370			
	Black	44369			
	Gray	44377			
D	Flush Activator	95002-Standard 95054-Positive		95183-3 White 95183-5 Biscuit 95183-7 Black 95183-11 Gray	95152
E	Air/Water Sequence Valve	39014			
F	Vacuum Breaker	39034		33421 Check valve	39034
G	Bleed-Off Assembly	94598			
H	Valve Bracket	94533		20137	20003
I	Hopper	90067-Rear Discharge 90065-Down Discharge		90057-Rear 90077-Down	90067-Rear 90065-Down
J	P-Trap, Rear Discharge	96029-Rear 90008-Bottom			
K	Hopper Bleed Valve	37548			
L	Hopper Screws	00064 (14 ea.)			
M	Air Cylinder	94540			
N	Flapper Assembly	90048			
O	Crank Assembly	90042			
P	Water Supply Tube	96012		96012-7	39033
Q	Water Connection	96387		N/A	
R	Hopper Gasket	27272			
S	Air Supply Kit	93086			
T	Pressure Relief Valve	37518			

AIRLINE CONNECTIONS - SERVICE KITS - AIR/WATER SEQUENCE VALVE COMPONENTS

AIRLINE CONNECTIONS

From Air/Water Sequence Valve	To	Part Number
Red	Air Cylinder, bottom fitting	35383
White	Air Cylinder, top fitting	35385
Black	Bleed Off Plug	35419
Green	Flush Activator, front fitting	35381
Blue	Flush Activator, back fitting	35382
Yellow	Hopper	35384

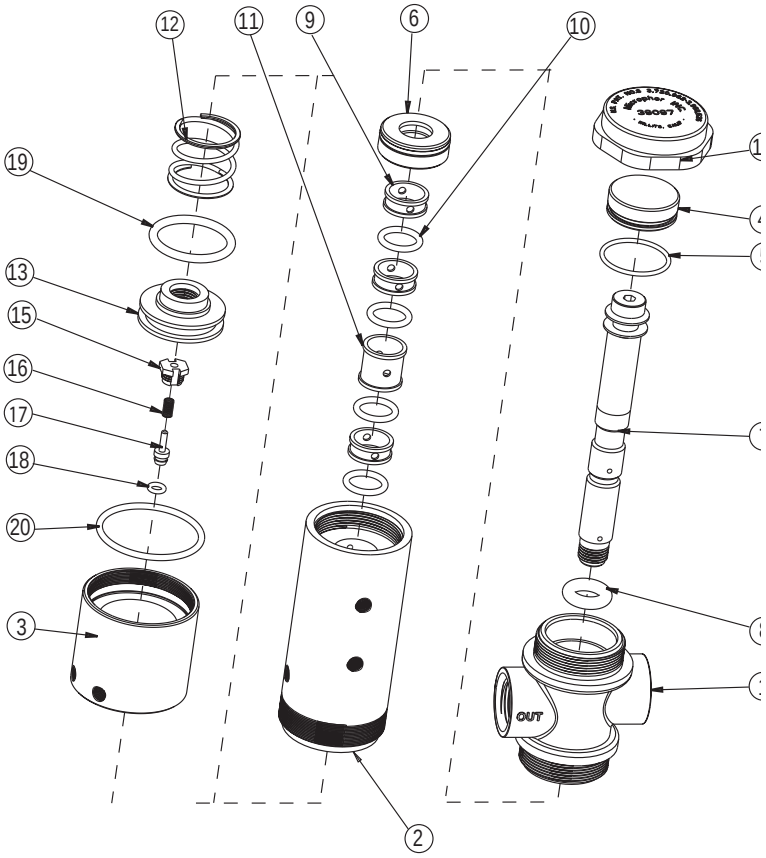


SERVICE KITS

Description	Part Number
Master Service Kit	93100
Air/Water Sequence Valve	95187
Air Cylinder	94502
Flush Activator Pilot Valve (standard)	95020
Vacuum Breaker	95037
Positive Flush (Detent) Valve	95081
Flapper Replacement Kit	90066

AIR/WATER SEQUENCE VALVE COMPONENTS

	Part Number	Description
1	39389	Water Body, A/W Sequence Valve
2	39388	Body, Main Valve
3	39096	Cap, Machined Bottom
4	**39099**	**Insert, Top**
5	**27214**	**O-Ring, 2-023**
6	**95173-3**	**Insert Assembly**
7	39394	Main Spool
8	**27242**	**O-Ring, 2-039**
9	39061	Main Spool Separator
10	**27250**	**O-Ring, 2-113**
11	39062	Secondary Spool Separator
12	**10888**	**Spring, SS**
13	39510	Blind Cylinder Piston
14	**39097**	**Thread Cap Nut**
15	**39088**	**Check Valve Nut**
16	**10886**	**Spring, Bronze**
17	**39087**	**Check Valve System**
18	**27251**	**O-Ring, 2-008**
19	**27253**	**O-Ring, 2-217**
20	**27244**	**O-Ring, 2-130**
21	**26013**	**Lubricant, O-Ring**

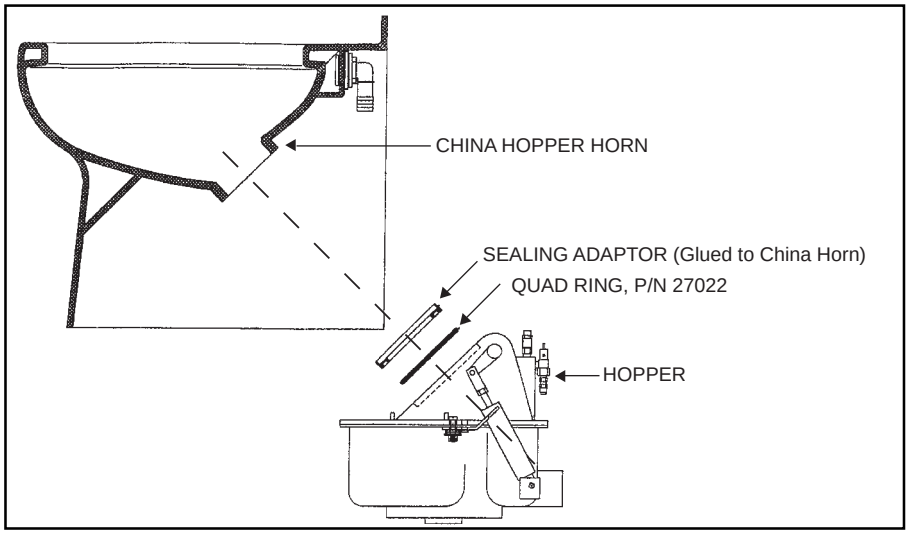


Items in **bold** are included in the Air/Water Sequence Valve Kit.

HOPPER REPLACEMENT

CAUTION: Read this entire procedure before beginning work!

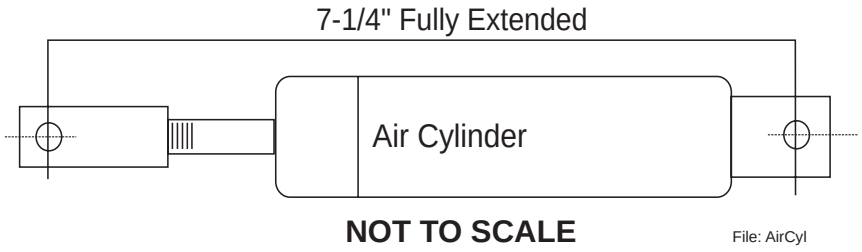
1. Remove toilet from floor. Place toilet upside down on a sheet of cardboard or other padded material.
2. Remove two (2) screws from either side of hopper and lift hopper from sealing adaptor.
3. Remove o-ring between hopper and seal adaptor. Check that o-ring is not damaged, replace if necessary.
4. Re-assemble in reverse order.



Note: The air cylinder on the hopper sub-assembly should be cleaned, lubricated and checked for adjustment whenever the toilet assembly is removed for servicing.

AIR CYLINDER ADJUSTMENT

1. Remove Hopper (see Hopper Replacement on page 9).
2. Remove the clevis pin retaining ring. Rmove the clevis pin.
3. Inspect the crank arm, clevis and clevis pin for wear. Replace if required.
4. Hold the crank arm in the UP position (flapper closed).
5. Fully extend the air cylinder and note the position of the holes in the crank arm and the clevis. The clevis hole should extend half its diameter pas the crank arm hole.
6. Adjust as necessary by loosening the locknut and extend or retract the clevis as required.
7. Re-install Hopper.



TO CHANGE FLAPPER GASKET:

1. Turn water and air off.
2. Reach behind flapper to grasp gasket tails.
3. Pull tails out of slots to remove old gasket.
4. Installation is the reverse of removal.
5. Tails must be pulled all the way through to ensure smooth surface.

AIR/WATER SEQUENCE VALVE OPERATION

1. In the normal rest position, pressurized air enters the Flush Activator and goes from Flush Activator Port 1 (Green tube) to Air/Water Sequence Valve Port 2, through Port 3 (Red tube) to Air Cylinder Port 4 holding the Flapper closed, sealing the water in the bowl and maintaining a proper water surface area.

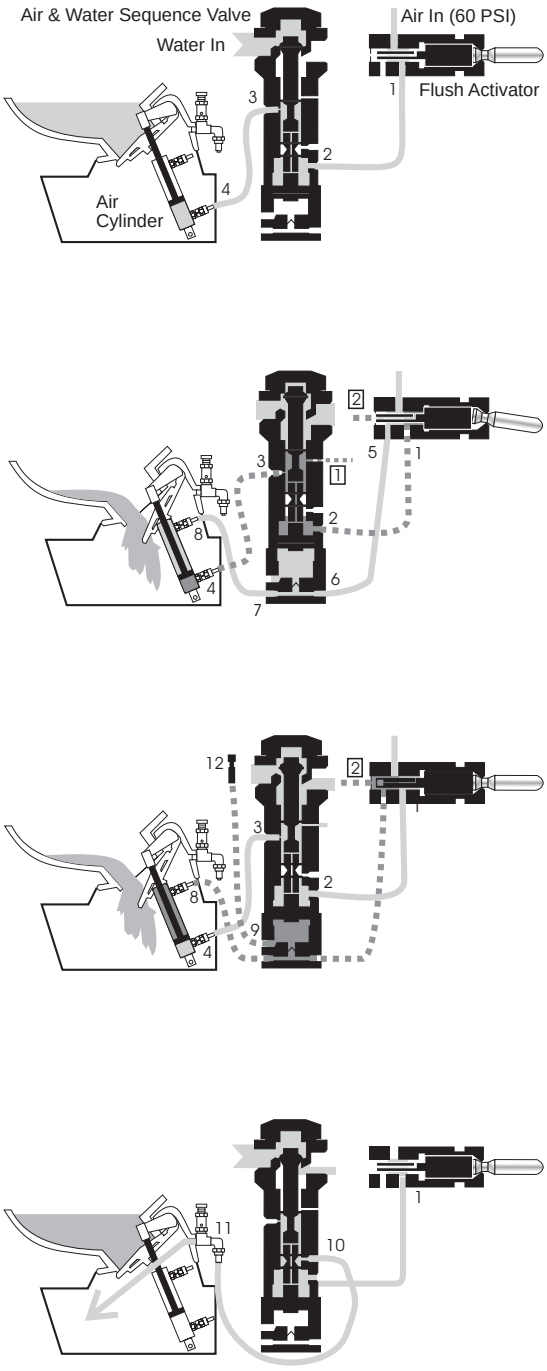
2. When the Flush Activator is pressed, air is shifted to Port 5 (Blue Tube) to A/W-Seq. Valve Port 6 and on to Air Cylinder Port 8 (White Tube). The air in the base of the Air Cylinder is bled off through Port 4 (Red Tube) to Port 3 and out Vent [1], allowing the Air Cylinder to retract, opening the Flapper. Simultaneously, pressurized air in the base of the A/W-Seq. Valve pushes the piston and spool assembly up to open the water passage, allowing water to enter and rinse the bowl. The air on the top of the piston is bled off through Port 1 and out Vent [2].

3. As the Flush Lever is released, the Flush Activator returns to the normal rest position redirecting pressurized air to Port 2, Port 3 and Port 4. The Bleed-Off Plug [12] bleeds off the air (Black Tube) under the piston, causing the spool to move downward, gradually closing the water passageway. The air having been bled off the top of the Air Cylinder Port 8 (White Tube) through the end of the Flush Activator Vent [2] (Blue Tube), allows the Air Cylinder to close the Flapper allowing water to accumulate in the bowl, restoring a proper water surface area.

4. Near the bottom of the piston stroke, the air passageway from Port 10 (Yellow Tube) to the Hopper Port 11 is unblocked for 4-11 seconds to pressurize the hopper and expel the waste contents over the trap and into the waste line.

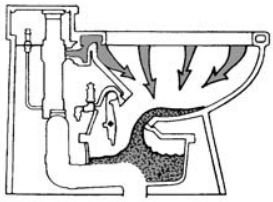
5. As the A/W-Seq. Spool reaches the bottom position, the water supply is shut off, completing the flush cycle.

In the event of air supply failure, the spring in the Air/Water Sequence Valve maintains the valve in the closed position, blocking the water passageway. The flapper will open and allow water in the bowl to flow into the hopper forming a water seal.

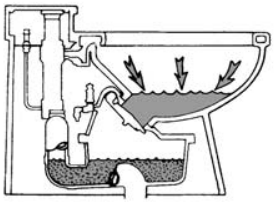


File: AWS-bw

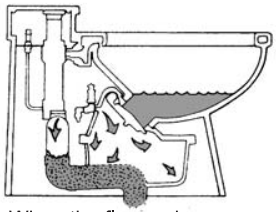
BASIC TOILET OPERATION



When the flush activator is pressed the flapper opens, allowing wastewater to flow into the hopper. Clean water enters the bowl from the rim to thoroughly wash the bowl.



After 4-8 seconds, the flapper closes. Clean water continues to flow into the bowl where it remains until the next flush.



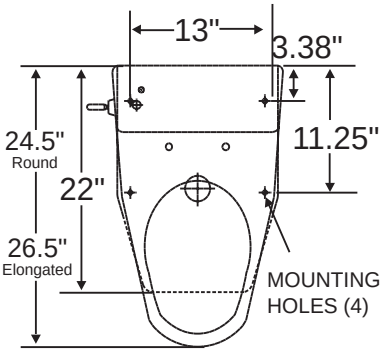
When the flapper has closed, compressed air enters the hopper, pushing the waste over the trap and into the wasteline.

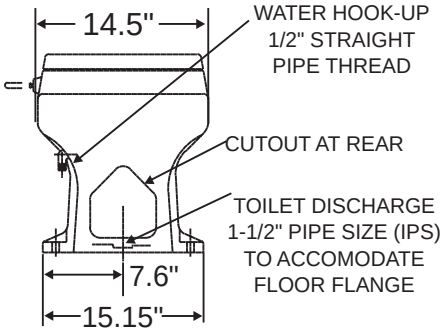
File: 210-op

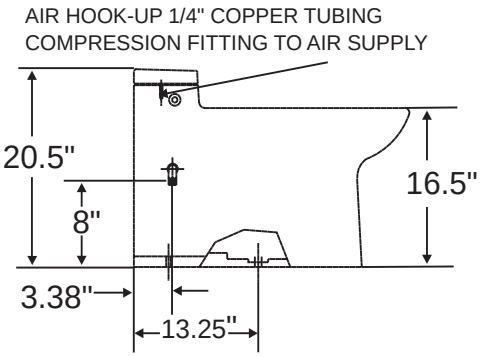
LF-210 ROUGH-IN DIMENSIONS

NOTE: All dimensions may vary ½" ±

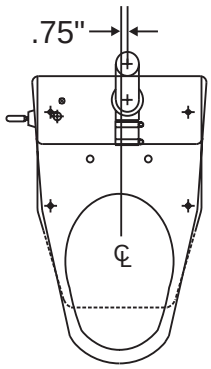
Downward Discharge

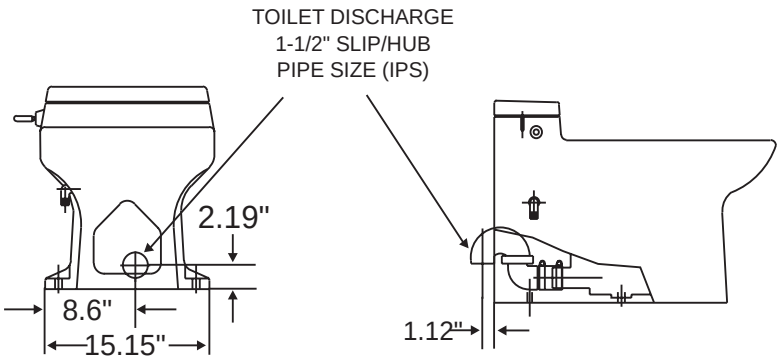






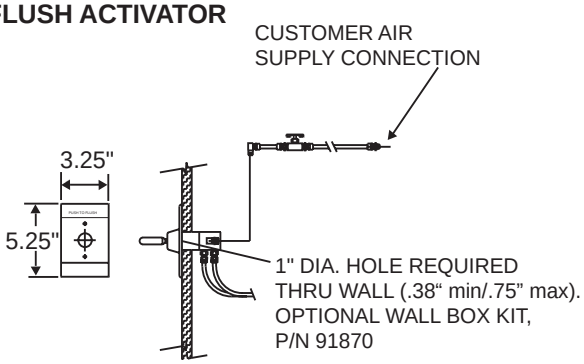
Rear Discharge



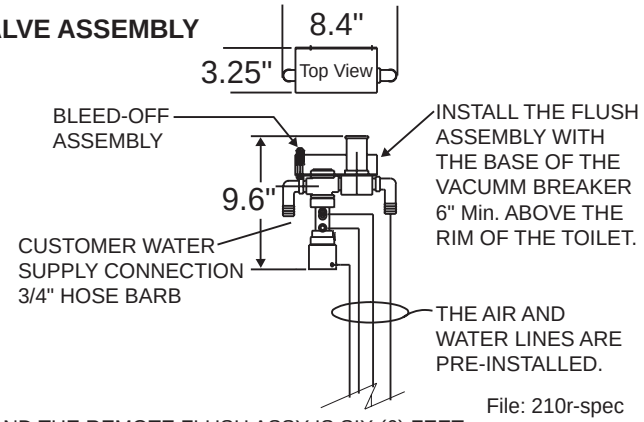


Remote Flush Rough-In

FLUSH ACTIVATOR



VALVE ASSEMBLY



File: 210r-spec

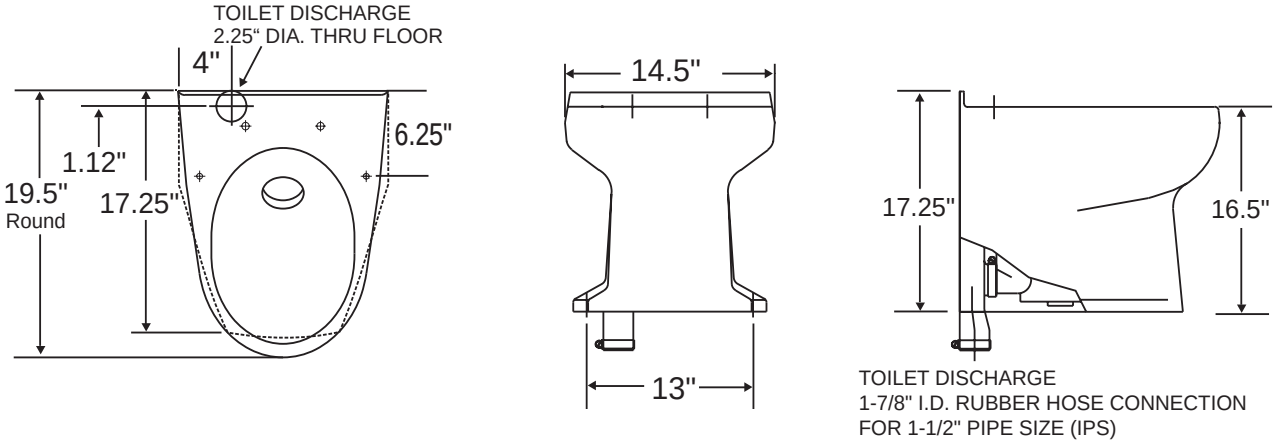
THE MAXIMUM WATER LINE DISTANCE BETWEEN THE TOILET AND THE REMOTE FLUSH ASSY IS SIX (6) FEET.

LF-219 ROUGH-IN DIMENSIONS

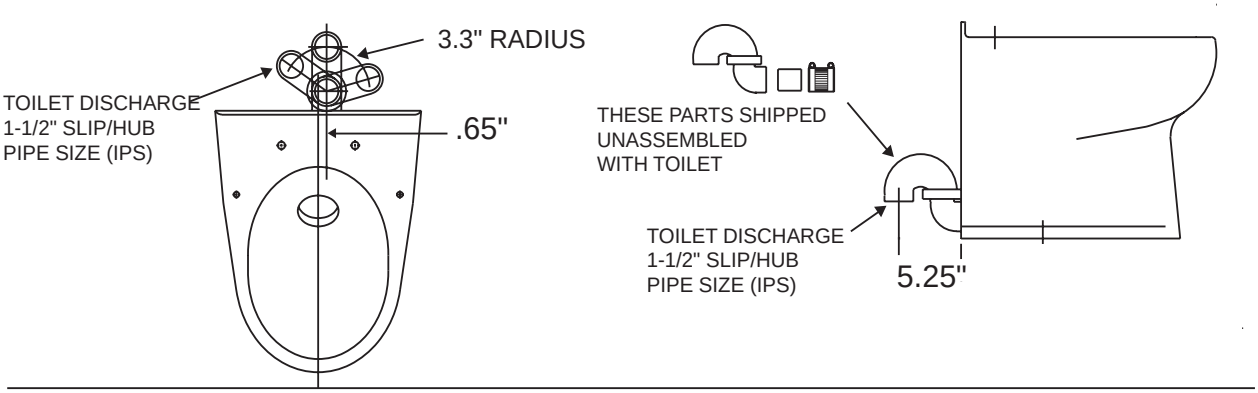
NOTE: All dimensions may vary ½"

NOTE: Do NOT use P-Trap in vertical rise waste line applications.

Downward Discharge

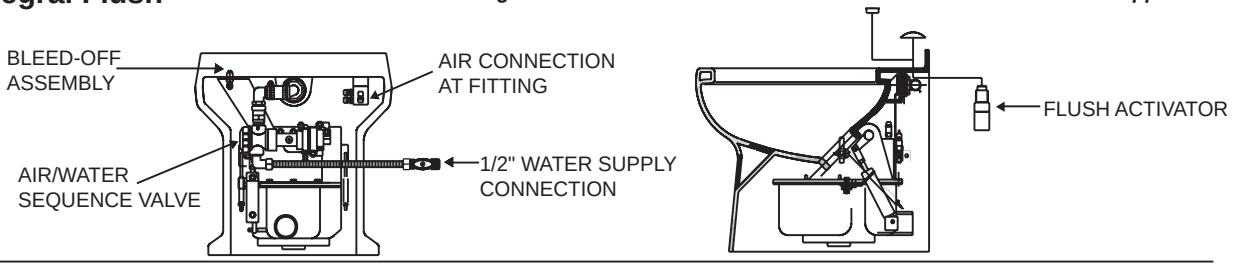


Rear Discharge



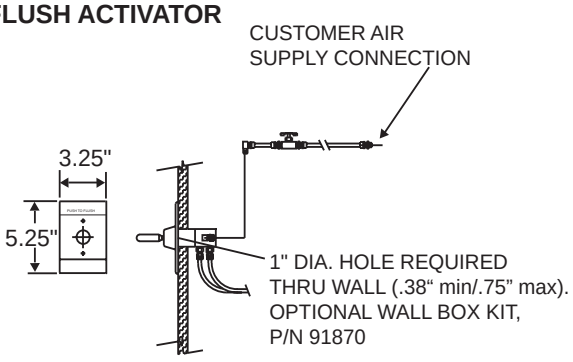
Integral Flush

Integral Check Valve - No Vacuum Breaker - Check Local Code for Approval.

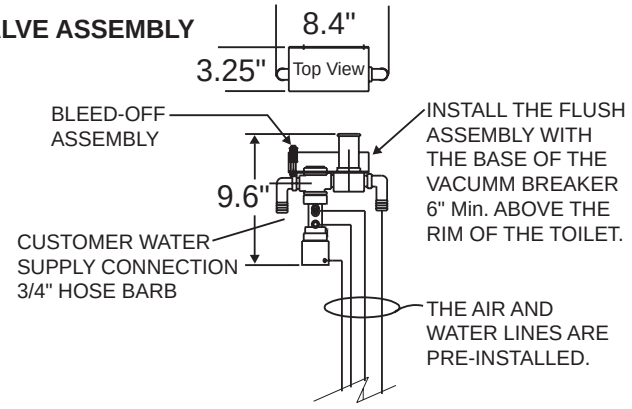


Remote Flush Rough-In

FLUSH ACTIVATOR



VALVE ASSEMBLY



THE MAXIMUM WATER LINE DISTANCE BETWEEN THE TOILET AND THE REMOTE FLUSH ASSY IS SIX (6) FEET.

File: 219-Spec

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